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BUILDING OF THE GREAT WACHUSETT DAM.

By J. A. STEWART.

THE construction of the great Wachusett Dam at Clinton, Mass., just inaugurated by the Metropolitan Water Board, of Boston, will provide that city with an extensive storage basin of capacity surpassed only by one other in the world—the Periyar Reservoir in India. The great retaining chamber created by building the dam will have an area of 6½ square miles. The average depth is 46 feet and the maximum depth 129 feet. The basin is 8½ miles in length, and the total length of shore line is 35 miles. Its capacity of yield is 105,000,000 gallons daily.

The plans for the construction of this important engineering work show many suggestive and interesting details. The work comprises the building of the waste weir, the core-wall, the gate chambers, and other structures along the dam, and the extension of Wachusett Aqueduct to the lower gate chamber.

The great dam is similar in some features to the Furens Dam upon the Furens River, in France, built in 1866, and to the Tansa Dam of the Bombay waterworks, constructed in 1891. It is located across a narrow gorge in the south branch of the Nashua River in the town of Clinton. Its water face will be about 275 feet below the center line of the temporary earth dam, which has already been built across the river. The entire construction is of granite masonry, built upon solid rock. The dam will have a length of 850 feet between the terminal structures, and its maximum height is likely to exceed 200 feet. At the northwesterly terminal, to be known as the bastion, the dam turns upstream and continues, with its top at a lower level as a waste weir, for about 450 feet, to a small abutment at the shore.

From the southeasterly terminal, known as the abutment, the core-wall will be carried into the hillside near the middle of the main dam. Two gate chambers are to be constructed, one on the upstream, the other on the downstream side. The latter is to serve not only as a gate-chamber, but also as a foundation for a power house, in which turbines and other machinery may be installed.

The Wachusett Aqueduct, which was completed in 1898, is to be extended to the lower gate-chamber. Four 48-inch pipes are to be built through the dam and the gate-houses to convey water to the turbines and to the Wachusett Aqueduct, which is already in use. Beyond the lower gate-chamber the pipes will be extended with diameters gradually increasing to 8 feet, and then will be further extended as masonry conduits having a maximum diameter of 10 feet to a pool through which water will be discharged into the river channel.

The waste chamber for conveying the water which discharges over the waste weir to the river below the pool is to be formed by excavating the earth and rock and building retaining walls. All the excavations made for the construction of the dam are, it appears, to be refilled, and embankments are to be made on both upstream and downstream sides of the dam. A large amount of grading will be required on the downstream side. Earth surfaces exposed to the action of the water are in many places to be protected from the waves and currents with rip-rap and paving. Surfaces not so exposed are to be neatly finished with soil.

As has been stated, an earth dam, known as the upper temporary dam, has been built across the river, both for the purpose of protecting the excavations for the main dam and of diverting water into the Wachusett Aqueduct for the supply of the Metropolitan water district. This dam is an embankment of earth with a row of sheet piling in the center to serve as a cut-off. Passing through it are two wooden flumes. The smaller one near the southeasterly end is 7 feet 2 inches wide and 7 feet 7 inches high, and is used to convey water to the Wachusett Aqueduct. The larger one, near the northwesterly end of this temporary dam, is for conveying the surplus water of the river across the excavations for the big dam. This flume is 40 feet wide and about 700 feet long. Its height is 16 feet at the upper end and 13 feet at the lower end. The flow of water through this large flume is controlled by stop planks at a head-house on the upper temporary dam. It is, of course, essential, during the construction of the foundations of the main dam, that there should be no overflow at the temporary dam, except into the large flumes, and it is also necessary that the flow through this flume should not be obstructed in times of freshet either by stop-planks or gates, or even by stop-plank grooves, which might collect such large obstructions as stumps, logs and floating ice; consequently, special machinery was provided, by which in a short time all of the stop-planks, gates and stop-plank grooves could be removed, leaving a clear passage through the flume. The small flume, which leads from the temporary dam to the head of the aqueduct, is so located that its foundation is several feet below the original surface of the rock, where the flume crosses the line of the masonry dam. This location added greatly to the difficulty of building the flume, as it required an excavation 40 feet deep, but it will make it very much easier to maintain the flume while the masonry dam is being constructed.

A second earth-dam, known as the lower temporary dam, has been built to prevent the backwater of the river from entering the excavations.

Extensive borings have been made preliminary to the building of the great dam, and a skillful geologist was employed to interpret the results and to determine the character of the substratum. Merrimac schist, calcareous gneiss, and the St. John's group constitute the geological formation.

The first process of construction is the excavation in the bottom of the valley, with a view to uncovering

WACHUSETT DAM, SHOWING TEMPORARY FLUME.

TEST BORINGS FOR FOUNDATION.

EXCAVATING THE TRENCH FOR THE WACHUSETT DAM.

LANCASTER MILLS SUPPLY.

the rock formation of the dam. The labor involves a total of 267,300 cubic yards of earth excavation and 100,000 cubic yards of rock. There are 335,000 cubic yards of rubble stone masonry and 10,300 cubic yards of ashlar masonry in the dam. The face dressing of rough-pointed work covers 18,000 square feet, and of fine-pointed work 30,000 square feet. The quantities of work to be done in other lines are: Brick masonry, 1,300 cubic yards; Portland cement concrete, 7,000 cubic yards; granolithic surfacing, 5,000 square yards; slope paving, 2,700 cubic yards; and broken stone in place, 2,300 cubic yards. The quantity of iron and metal work is 1,000 tons. There are 10,000 square yards of roadways and paths to be constructed.

As it is the intention of the Boston Water Board to use the Wachusett Reservoir for the storage of water during the construction of the dam, the process of building will be necessarily slow. Before the new year it is expected that the earth excavations will be accomplished. By June, 1902, all of the work required for diverting and conveying the water through the 48-inch waste pipes and conduits and the protective works to prevent damage from the discharge of water is expected to be completed in readiness for the removal of the large flume. November, 1904, is the date set for the completion of the great dam.

The construction of this massive retaining wall will complete the far-sighted plans of the Boston Water Board, by which the pure water of the Nashua watershed, having an area of 118 square miles, will be available for the uses of the people.

LIGHT RAILWAYS IN NATAL.

A LATE number of The Board of Trade Journal contains a notice of this subject from Industries, a journal published in Natal. It is stated that few have any idea of the extensive use made of light railways in that colony, or the relative cost of this means of transport compared with the old methods. There are not less than 175 miles track of 12-pound to 20-pound rails laid down; the gages varying from 18 inches to 30 inches; and this length of line is constantly being increased. These 175 miles track have to serve over many hundreds of miles. Take the Tongaat Sugar Company, Limited, for example. This estate possesses 22 miles of track, 8 being permanent and 14 portable. These 14 miles of portable track are placed once a year over the whole of the 180 miles of roads cut through their cane fields. The gage used on this estate is 24 inches gage, which the majority of the planters consider most suitable for cane transportation. When animals are used for drawing the trucks, the 12 pound rail has proved itself to be the most suitable section; but where steam traction is employed, 16-pound rails are preferred. For heavier work than that on sugar estates, 16-pound rails should be used for animal, and 30-pound rails for locomotive traction. Four miles of 16-pound rails are used on the largest wattle farm in the colony; the poles being carried on a dozen two-bogie trucks, the construction of which has been slightly altered to suit their special requirements. The following particulars may be of value to those intending to adopt this expeditious and economical method of transport:

	With sleepers 2½ ft. apart.	3 ft. apart.
12 lb. rails can bear a wheel pressure of..	1,630 lb.	1,430 lb.
16 lb. rails can bear a wheel pressure of..	2,360 "	2,050 "

Thus by increasing the number of wheels to a locomotive it may be utilized for working on 12-pound rails. Take, for instance, the most common style of track—12-pound rails and sleepers three feet apart. A four-wheeled locomotive with a total wheel pressure of 7,000 pounds would be too heavy for working on it; whereas, by the addition of another pair of wheels there would be over 1,500 pounds to spare. It would appear that much economy can be effected by planters investing in light railway plant.

When the steel market is normal three miles of track and a dozen trucks of the above type—six with brakes, six without—constructed to carry 3000 pounds of sugar cane, can be purchased at under £1,000 delivered. With regard to the outlay of the planter who employs the regular type of ox wagon seen on the plantations, the wagons cost him £20 each and carry about 2,000 pounds. Therefore, to transport as much cane as the twelve trucks mentioned above would carry, he would require 18 wagons, at a cost of £360. He will require four oxen per cart, viz., 72 oxen, but as some of the oxen are always lame, or sick, he cannot work his 18 carts without keeping at least 80 oxen, which, putting the cost of the oxen at only £8 apiece, would bring up the outlay for carts and oxen to £1,000. Beyond this is the fact that far more work can be done with a tramway than with the old system of carts.

The uses of light railways are not limited to sugar estates. Contractors, brickmakers, etc., are large users for they find that with rails and side-tipping trucks they can turn out far more work than hitherto accomplished and at much less cost.

Industries adds that in the course of the next few years it is possible that many of the large farmers in the colony will be making use of this economical method of transport for manuring their lands, carrying their crops, etc.

CONTEMPORARY ELECTRICAL SCIENCE.*

TEMPERATURE OF THE ACETYLENE FLAME.—From the heat of combustion of acetylene, its temperature is calculated to be between 2,100° and 2,420°. But the experimental values so far obtained vary from the melting point of platinum down to 1,400°. That some parts of the flame possess a temperature higher than the melting point of platinum may be proved by introducing very fine platinum wires into it, and showing that they melt. E. L. Nichols has made some careful measurements by means of thermo-couples consisting of fine platinum and platino-rhodium wires. The difficulty in all such measurements is to avoid conduction, which reduces the temperature of the hot junction below that of the flame in which it is immersed. The author has, therefore, employed the expedient of using four different diameters of wires, ranging from 0·19 mm. to 0·08 mm., and extrapolating the curves thus obtained down to a zero diameter. The temperature of the hottest portion thus obtained was found to be 1,920°, or 100° above the highest temperature obtained with the thinnest wire. An ordinary gas jet under the same conditions gave a temperature of 1,780°, or a few degrees above the melting point of platinum. Commercial Wollaston wires may be melted even in a candle flame, but then they are not pure platinum.—E. L. Nichols, Phys. Review, 10, 1900, and Physikal. Zeitschrift, October 20, 1900.

BECQUEREL RAYS.—M. Maier describes a particularly active radium preparation obtained by Giesel. It shows a clear white spontaneous luminescence. On a highly sensitive bromide plate its rays produce a strong impression in 30 seconds, while the ordinary pitchblende requires an hour for the same amount of action. The rays are capable of penetrating an iron plate 4 mm. thick and a layer of mercury 20 mm. thick and yet producing an impression in four minutes. The substance has shown no measurable diminution of radio-activity in the last eight months. The author has found that the magnetic deflection of the rays is very sensibly diminished by placing the substance in a vacuum. Efforts to obtain evidence of refraction and regular reflection failed. Special attention was paid to diffraction and interference. The rays were sent through a slit 1 mm. wide, formed by very thick steel plates, and had further to traverse a slit 0·05 mm. wide. But no diffraction was observed, thus confirming Becquerel's negative results. Equally unsuccessful was the attempt to produce polarization by means of tourmaline. But all bodies appear to produce diffused reflection of Becquerel rays, and some bodies, like ebonite, aluminium, lead, and iron, acquire a secondary radio-activity on prolonged exposure, which disappears, however, in a short time.—M. Maier, Physikal. Zeitschrift, October 20, 1900.

SECONDARY ELECTROLYTIC ACTION.—If after the electrolysis of a concentrated solution of "hypo" the quantity remaining in solution is determined, it is found that the quantity which has disappeared does not correspond to that calculated from the transformation of the hypochlorite into chloride at the cathode, and of the formation of chlorate at the anode. More hypochlorite disappears than is foreseen by the theory, and too much chlorate appears. The amount of the error is very great, often attaining over 25 per cent., and it increases with the concentration of the salt. A. Brochet accounts for this irregularity in the following manner: The immediate neighborhood of the anode is always acid; hence, besides the hypochlorous acid transformed into chloric acid by the current, some of the highly-concentrated acid undergoes spontaneous oxidation. An attempt to produce this phenomenon at feeble concentrations failed, owing to the impossibility of obtaining consistent values. The secondary electrolytic action is the reason why no hypo solution can be effectively electrolyzed with a concentration amounting to more than 12·7 grammes of active chlorine per liter.—A. Brochet, Comptes Rendus, October 15, 1900.

HARMONICS IN ALTERNATING CURRENTS.—A considerable element of the danger to human life attending the use of alternating currents lies in the "harmonic" currents superimposed upon the sinusoidal curve. To eliminate these harmonics, Pérot proposed the employment of synchronous motors of small inductance. G. Claude has devised a means which is based upon the use of suitable condensers. If the alternator has a resistance R and inductance L, and it is branched with a circuit having an inductance L^1, a resistance, R^1, and a capacity, C^1, a harmonic characterized by the equation

$$e_n = E_n \sin n\omega t$$

may be reduced to any desired extent by giving a small value to R^1 in the equation

$$e^1_n = E_n \frac{R^1}{\sqrt{(R+R^1)^2+(n\omega L)^2}} \sin(n\omega t - \varphi_1)$$

The resonating circuit would practically only affect the harmonic it was intended to neutralize, and would leave untouched the fundamental sinusoidal curve. A disadvantage in comparison with Pérot's method lies in the fact that a special resonating circuit would be required for each harmonic. On the other hand, the resonating circuit is inert, and offers no risk of introducing fresh harmonics, as Pérot's synchronous motors are apt to do.—G. Claude, Comptes Rendus, October 15, 1900.

ATMOSPHERIC POTENTIAL DURING A SOLAR ECLIPSE.—Some time ago (see The Electrician, vol. xiv., p. 880, October 5) Oddone published the results of an attempt to discover an influence of a solar eclipse upon the atmospheric potential. The results were very doubtful. There appeared to be a slight increase of positive potential, but that may have been due to the formation of clouds. J. Elster was so fortunate as to take some observations near the town of Algiers, within the area of totality, and therefore of much greater importance than the Pavia observations. He found a steady and decided diminution of the positive potential from 177 volts at 12:30 P. M. to four minutes after totality, which occurred at 4:29 P. M. The minimum observed was 113 volts, and at 5:47 P. M. the original potential was nearly attained. This looks like a well-established connection between potential and solar illumination of the atmosphere. The author inclines to the opinion that during the eclipse masses of air were aspirated from the sea which had different electric charges. As a matter of fact, a fresh breeze was blowing in from the sea during the whole afternoon. The result is directly opposed to that of Oddone at Pavia, unless we assume that there is some casual connection between them. On the other hand, the new observation corroborates that at Wolfenbüttel in 1889, which showed an increase of positive potential after totality.—J. Elster, Mem. Soc. Spettroscopisti Italiani, 29, 1900.

NEUTRAL POINT OF THERMO COUPLES.—A. Abt describes a simple method of determining the neutral point in thermo couples which is specially suited to demonstration purposes. It is based upon the equation

$$E = (t_1 - t_2)[a + b(t_1 + t_2)]$$

The temperatures of the junctions are changed until the current disappears. When that occurs, the neutral point is the arithmetical mean of the temperatures t_1 and t_2 of the junctions respectively. The arrangement as described consists of two wooden frames with openings closed by plates of asbestos, one on each face of the frame. Holes are bored in the plate, and thick steel rods are inserted through the holes. One end of each rod contains receptacles for the bulb of a thermometer and for one junction of the thermo couple, while the other is heated by a Bunsen flame. Images of the thermometers and of the galvanometer scale are thrown upon a screen, and the heating is carried on until the current disappears, or until it reaches a maximum, while one junction is kept at the temperature of the room. The neutral point is 117° in a brass-lead couple, 276·8° in an iron-silver couple, and 232° in an iron-zinc couple.—A. Abt, Ann. der Physik, No. 10, 1900.

* Compiled by E. E. Fournier d'Albe, in The Electrician.

[Continued from SUPPLEMENT, No. 1301, page 20858.]

ELECTRICAL ENGINEERING AS A TRADE AND AS A SCIENCE.*

MUCH of the evil we suffer from is due to our average young men being pitchforked into works where they get no instruction as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters could be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through common-sense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science; and he learns what he calls mathematics in such a fashion that he hates the sight of a mathematical expression all his life after.

And what is the result? English engineers do make a wonderfully intimate acquaintance with the machines and tools that they work with, but when it comes to the manufacture of new things, they do it by fitting and trying, by quite unnecessary expenditure of money through trial and error. A machine is made and tried, and then another better one, until a good result is arrived at. And this method did well enough in the past, and would do well enough in the future if only we had not to compete with foreigners who can really calculate. It is not all smoke; there is a real danger in this foreign competition unless we mend our ways. There is an absolute necessity for great change in English ways; but there are so many people interested in the maintenance of old methods of working, so many people who think they will lose their bread and butter if a change takes place, so much capital, scholastic and other, invested in our old machinery, that it takes a catastrophe to produce changes. Much of the strength and weakness of England has always lain in her conservatism. We have been talking of standardization of machinery lately, so I may say that things have been standardized in England for a long time. Now, to get all the good effect of standardization, it is occasionally necessary to go in for wholesale scrapping, and it is this scrapping part of the business that we dislike in England. We here all know that the District and Metropolitan Railways might have been worked electrically years ago just as easily as they will be when we are allowed to begin upon them, but, of course, the scapping of a lot of steam locomotives was a serious thing. The loss of experience to English electrical engineers, because of this hatred of scrapping, is leading to other incalculable losses. I understand that the whole generating and line plant—the whole machinery of the Boston tramways—has been scrapped several times since they first were driven electrically. Japan has scrapped all her old civilization just as France did. During the century now dying Germany has made the most sweeping changes in her law and school legislation, and, indeed, in everything. England and Spain and China, how they differ in this respect, even from England's own colonies!

Of course, it may be said that English customs have grown during centuries, they are well tried, and there is no pressing need for sudden alteration. I quite agree, but, unfortunately, this very perfection and fitness of our customs have bred in us a want of flexibility, so that in cases where a sudden change is really necessary, we are disinclined to make the change merely because it is a change and for no other reason.

No one has ever heard me speak of the decadence of England. When the greatness and the wealth, the manliness and the strength, the healthiness and good life of England are shown forth to the as yet ignorant world in all their magnitude, there will be some astonishment. But it is our duty to keep up our high standards. We must change what is bad when we know it to be bad, and not let bad things† continue to exist, parasitic growths, maintained because on the whole we are strong and healthy. You will perhaps think that this is a very serious exordium when I tell you that I have introduced it all on account of the state of mathematics in our profession. I feel a sort of degradation every time that I hear a successful, clever old member of this institution sneering at mathematics. There is a plausibility about his statements; he himself has been very successful in life without much help from mathematics; but indeed his sneer is doing a great deal of harm to the younger members who admire his success, who forget that he has succeeded in spite of, and not because of, his neglect of mathematics.

Our knowledge of electrical phenomena must be quantitative to be of practical use; we must be able to calculate. Mathematics is the science of calculation, and we must, therefore, be able to employ, and we all do necessarily employ, less or more mathematics every hour of our professional lives. The draper and the grocer and the housekeeper need merely arithmetic. Everybody knows some arithmetic. Everybody can add and subtract and multiply and divide, and keep accounts in some simple sort of way. This is due to the fact that arithmetic is no longer

* Inaugural Address, delivered at the Institution of Electrical Engineers on November 8, by Prof. John Perry, F.R.S., President.

† Such as our wretched system of weights and measures. O young America and Australia, is it wise to waste a year of every child's life, and years of the life of every business man, merely because we do it in England? You get many of your pedagogues from us, and, of course, they say that without cwts., qrs., lbs., and Latin declensions and Euclid, the mind cannot be trained. Do you believe them, or are you with open eyes making a great sentimental sacrifice?

taught in the old Greek method with its twenty-seven independent characters (for our ten figures), the study of which required a lifetime, so that only old men could do multiplication; and they not only needed many hours to do one easy bit of multiplication, but declared that if the art were not practised every day, it could not be remembered. Reading and writing and ciphering are now taught to everybody. It used to be that only learned men and philosophers could read, write and compute. You will remember the charge that was brought against one of Shakespeare's characters, who was said to possess mere bookish theory without practical knowledge. "And what was he?" "Forsooth a great arithmetician." Nowadays, when everybody can compute, we should say of the possessor of mere bookish theory, "Forsooth he knows the calculus."

For, in medieval times things were taught in such a way that only a few men had a chance of knowing how to read, write and cipher. We have been compelled to change all that; the pedagogue has, by compulsion, given up his medieval methods of teaching in these things, although in all other matters he retains them. But a time has come when we see that ciphering is not enough mathematics for us to be familiar with, we need a little algebra, we need coordinate geometry, we need the differential and integral calculus. The pedagogue tells us that we must follow the orthodox course of study, which takes many years; and some of us, many of us, who have followed the orthodox method, find that we have spent so much time and mental power upon it and its thousands of unnecessary tricks and contrivances and philosophy, that we can take in no more ideas. We cannot utilize our mathematics on engineering problems because we are too old and tired and blasé to comprehend these problems. Nevertheless we are the only people who know mathematics, and so we publish volumes of unmeaning and useless disquisitions on problems that we do not understand. Or we know just enough mathematics to be able to show our ignorance to experts, but quite enough to impress engineers with our knowledge; and we know just enough about engineering problems to show our ignorance to engineers, but quite enough to impress mathematicians, and what we publish is merely as the crackling of thorns under a pot.

As for the man who does understand electrical problems, he remembers that there was a something called a study of mathematics at his school, that he did pass certain examinations with much difficulty and tribulation, that the subject had no real meaning to him even when he was supposed to know it, and he now hates the sight of anything that looks like mathematics.

I tell you, gentlemen, that there is only one remedy for this sort of thing. Just as the antiquated method of studying arithmetic has been given up, so the antiquated method of studying other parts of mathematics must be given up. The practical engineer needs to use squared paper. What is the use of telling him that he has taken an unauthorized way to the study of coordinate geometry, that he cannot approach it except through Euclid and modern geometry and geometrical conics and algebra and trigonometry? He says the youngest child can be made to understand diagrams on squared paper.

So again the idea underlying the calculus is one that every child, every boy, every man, possesses and uses every day of his life, and there are useful methods of the calculus that might be taught quite quickly to boys, and which it would be a pleasure to boys and men to use continually in all sorts of practical problems; but of course the subject of the differential and integral calculus is one that must come at the end of a long course of what is to the average boy utterly uninteresting and unmeaning mathematics. Indeed, the average boy never reaches the subject, whose very names, differential and integral calculus, are enough to drive him frantic.

Yes, the schoolmasters say that we must follow the medieval rules of the game, and all sorts of fine things are said about them; but as a matter of fact we only need to bring a little common sense to bear upon schoolmasters. At present most of us stick to our arithmetic as a safe and well-tried friend. We compute after the manner of the draper and grocer and housekeeper. In finding out what is the best size of conductor, or armature winding or core, or iron and winding of a field magnet, we calculate by mere arithmetic for one size and then for another; perhaps we have weeks of arithmetical computation before we find the right size of thing to use, and we cannot frame general rules. And some foolish person who knows a little mathematics works at the problem (as we ought to be able to do, but are not), and he frames a general rule and we laugh at it, and sneer at mathematics because he has probably left out of account the most important consideration. We know that the result is wrong, but we cannot say why it is wrong.

Then there are some far-reaching, labor-saving ideas that we simply cannot get into our heads at all; we cannot comprehend them. Am I sinning against the rule as to good comradeship which exists here if I say that some of us are ignorant of the most fundamental facts regulating economy in arranging sizes of conductors? Suppose we find the total cost of installing a conductor of a certain length, using one square inch section of copper. We do the same thing for other sizes, and we plot total cost and weight of mere copper on squared paper. I do not care what system we adopt if it is the same system for all sizes, and if we buy our materials from the same manufacturers and use the same kind of labor, our points will be very nearly in a straight line on the squared paper. Hence increased cost will be proportioned to increased weight of copper, and, indeed, increased total cost will be like the mere increase in the cost of copper, taking a slightly higher price of copper per ton. Some of us, ignorant of the elementary mathematics involved in the problem, think that the mistake has been made of assuming that the cost of an installed conductor is merely the cost of the copper in it, and, of course, he must feel that it is too absurd a mistake not to be laughed over. With an elementary knowledge of mathematics his mistake would be impossible, and without such a knowledge the clever electrical engineer is constantly discovering mares' nests in the investigations which he criticises.

I know of long misleading accounts of the results of good experimental observations which might have been described in a few clear words by the aid of elementary mathematics. I know men who spend on a particular problem ten times the amount of worrying thought that would enable them to master the easy mathematics that includes all such problems. Quite recently one of our most eminent members declared to me that he had not really grasped the reason for small economy at a power station when there is a small load factor until he studied the common-sense mathematical form which has been given in a recent publication. And yet he is a man who has heard much, and read much, and talked much on this subject.

Every electrical engineer has a correct idea of how a transformer acts, or how the E.M.F. in one of the coils of an armature of a direct current or other generator, or, let us say, a rotary transformer, changes during a revolution, and how the E.M.F.'s of all the coils are combined to produce currents in the external circuits. But through how much mathematical tribulation must most of us have passed from our state of ignorance to our present state of knowledge! It is no wonder that we are disinclined to the study of a new phenomenon which seems as if it might lead us through the like tribulation. The tribulation is least because it is suffered only once if we first learn the calculus method which underlies all our work; it is greatest if we get it up in a completely new-looking form in every new problem. I speak now of what is most difficult in our study, for there is thought required in applying the calculus method. Thus, for example, in multiphase work at the present time the best mathematicians wonder how it is possible for easy calculation to be made in such a subject. What we want just now is that an electrical engineer acquainted with three-phase current phenomena should be so much a master of ordinary easy mathematics that he has a chance of discovering a very simple way of putting the matter before us. At present calculation is easy but tedious, and, indeed, repellent; but I am perfectly certain that a competent man might quickly invent methods of calculation which are not only easy but short and thinkable. Mathematicians with the requisite electrical knowledge, again, may be lacking in sympathy and humor. I know a book of more than three hundred large pages on ordinary alternating currents, and all the information in it is given far more simply in two pages of another book with which some of you are acquainted. Possibly, just now, mathematicians who are electrical and who have common sense have too much other work to do, and we must wait their leisure.

The fact is, mathematics ought to be the natural language of the electrical engineer, and at present it is a foreign language; we cannot read or write or think in it. We are at the beginning of our development, like monkeys whose necessities have increased faster than their powers of speech.

Some of you are aware that a new method of teaching mathematics has recently been introduced in nearly all evening classes in science schools throughout the country.* I wish I could say that there was a prospect of its being introduced in all schools, for it seems to me that this would lead to the result that all young men entering works would be masters of that kind of calculation which is most important in electrical engineering; not merely a few men having this power, but the average men, just as average men can read and write.

I am addressing engineers, men who utilize the results arrived at by scientific workers, men whose profession is applied science. But surely if we are to apply the results arrived at by scientific men, if the laboratory experiment of to-day is the engineering achievement of to-morrow, we ought to be very much alive to all that is going on in the scientific world.

All men ought to be far more alive to the importance of scientific work. On the psychological side, it is perfectly exasperating to me to see how few are the men who know that Darwin has given a key to almost all the great philosophical problems of antiquity, and that there is a great mental development accompanying the more evident engineering development now going on in the world. Again, it is the fault of our methods of education that all our great men, our most important, most brilliant, best educated men; our poets and novelists, our legislators and lawyers, our soldiers and sailors, our great manufacturers and merchants, our clergymen and schoolmasters, should remain so ignorant of physical science, the application of which by a few men not ignorant is transforming all the conditions of civilization.† But, of all men, just think what it means for engineers to be ignorant of science, or neglectful of its new developments; and, of all engineers, think what it would mean if electrical engineers sinned in this way.

Except ours, all other branches of industry have taken thousands of years to grow. There were bridge and hydraulic and sanitary and harbor and river engineers in ancient Rome, and such engineers existed thousands of years before the first papyrus was written in Egypt. But no Assyrian tile or Egyptian hieroglyphic or relic from a tomb indicates that telephones or electrical motors or electric lights existed before our time. No gradual improvement in our methods of conquering nature led up from small beginnings in our electrical engineering. Our profession has not grown during thousands of years of time, like other professions. It has sprung suddenly, full grown, from the new spirit which is going to rule the souls and bodies of men, the spirit of research in pure science. The new spirit puts knowledge, mere knowledge of nature, as its highest aim. The scientific student knows that all sorts of good must come to mankind from his studies; all sorts of scientific knowledge are sure to be utilized by engineers, but in the pursuit of science the usefulness and utility of the results are of no importance. And are we—we who have received the first-fruits of the labors of scientific men, we the first-born spoilt children of the great parent of all that is to come, we who form the foremost files of the present time—are we going to turn upon our beautiful young mother and say she is useless and ugly, and she hinders our money-making, and that we are willing to kill her for the sake of the burial fee? Thank God that is the spirit of only a few of us. Have we not as an Institution gone to great expense in the publication of Science Abstracts in partnership with the Physical Society? That publication has been and continues to be of the very greatest value to all students of pure and applied science who read our language, for it tells them the results of all the scientific work now being done in all parts of the world. And even if some of us do not read that useful publication, do we not know that it is there to read if we like? Do we not know that it is a symbol of our redemption from the yoke of the Philistine? It is one of many signs that in answer to the question which I have asked in this address, we can truthfully say that we are professional men, that our profession has promise of enormous expansion and improvement, and that we are not mere tradesmen.

I am afraid that you will think that I have a personal interest in putting before you the claims for consideration of the pursuit of pure science, because you know that I am trying to defend Kew Observatory from imminent danger. In truth I have no interest in this matter unbecoming a president of this institution. For two years I have been trying to reason with traction engineers. Like many other electrical engineers, these gentlemen desire to use uninsulated return conductors. If they do so near a magnetic observatory, certain records of terrestrial magnetic disturbances are quite spoiled. At Potsdam this sacrilege has been forbidden. At Washington, Toronto, Capetown, and most other important places, the magnetic records have already been rendered useless. Prof. Rücker and I were asked by the other members of the Committee of the Royal Society which was in charge of the Kew Observatory to defend Kew, and with the help of her Majesty's Treasury we thought we were able to insist upon the use of insulated returns in all undertakings authorized by Parliament where harm was likely to be inflicted on government observatories. I may say that the scheme designed by Mr. Clifton Robinson for using an insulated return conductor in the working of the tramways of the London United Tramways Company, in consequence of our action, was a thoroughly good scheme which it gave one satisfaction to look at, not ugly and not expensive. It seemed to me a fit scheme for any tramway system, however complex, in which overhead conductors are used. You are aware that for an electric railway or for a tramway where a conduit is employed, it is in every way better, and is in a large scheme actually cheaper, to use an insulated return. We felt, therefore, very happy, for magnetic observatories seemed quite safe from interference. We were, however, mistaken, for the only clause which we have been able to get inserted in all Parliamentary authorizations of undertakings leaves it to the Board of Trade to substitute other methods of protection than the insulation of the return conductors in cases where these other methods seem to be sufficiently good for the protection of laboratories and observatories, and this is why the Board of Trade appointed the committee which met on October 31 probably for the last time.

Prof. Rücker, Prof. Ayrton and I have made many tests on the magnetic disturbances produced by tramways and railways, particularly by the Stockton tramways and by the Waterloo and City Railway, and we have had many meetings with the traction engineers, but nothing has yet been decided.

I mention this matter, which has given great anxiety to scientific men, because I am afraid that some of you may think when you hear of it that I have been acting against the interests of the electrical industry. I beg to assure you that I have been acting in your best interests. As an electrical engineer, I ought surely to regret the use of uninsulated returns, even if we leave Kew Observatory out of account. Suppose we do not now insulate our returns. Electricity will certainly return by gas and water pipes, and the amount of harm done to those pipes is merely a question of time. Because of the ignorance of legislators and gas and water companies, nothing is said just now; but will nothing be said at the end of ten or twenty years, when pipes are found to be eaten away everywhere? And if, by a slight increase of expense, or rather, as I think, actually no increase of expense, but merely a little increase in inventiveness and common sense on the part of electrical engineers, this evil may be entirely prevented, surely it is in the interests of all of us that insulated returns should be insisted upon. But even if we do not insist on insulating the returns in all systems, surely something may be said for the giving of this protection on lines near such a magnetic observatory as Kew. Even the magnetograph records now being made have been continuous for forty-five years, and if Kew is interfered with no sum of money can compensate for the interference; for if the observatory were removed, the future observations would have no link with the past.

An engineer in this room declared that it seemed to him an injustice to hamper the progress of electric tramways "for the sake of making observations that never have given, and never may give, to the world any important results." Now, it is not so much on account of Kew that I object to this sort of observation, as to its general spirit of antagonism to scientific research.

There is no doubt that the answer to the old question, which Gilbert might have asked three hundred years ago, "What is the cause of terrestrial magnetism?" is very jealously hidden from us by Nature. The earth probably contains much iron, but its great internal heat seems to forbid our imagining the iron to be magnetic. The assumption that a negative electric charge on the rotating earth will explain things requires such an enormous charge that this assumption has been discarded. There are annual and diurnal variations of a fairly regular kind; there are storms which have some relation to the Aurora Borealis, to sunspots and to earth currents. There are small sudden changes which seem to occur almost instantaneously all over the earth. Observations of these things may be useless from some points of view, but scientific men have been, and continue to be, willing to give up time and much money for this object. Utilitarians had to be cajoled through superstition to allow observations of the stars to be carried on in ancient times, and we have no such cajolery to offer. We simply say that it has been through

* See summary of Lectures on Practical Mathematics; also the Science and Art Directory, and the Reports of Examiners on the Science Examinations of 1899 and 1900, all published by the Education Department, South Kensington, S. W. The reforms now advocated in mathematical and science teaching are all clearly described in a paper read before the Society of Arts in January, 1880.

† See articles in Nature of July 5 and August 2.

this sort of useless looking method of working that all our progress in science has come.

Engineers, descended from men who sneered at Cavendish and Franklin and Volta and Oersted and Ohm and Faraday, are you who utilize the results of the work so sneered at, and pile up fortunes in consequence of it, are you the men to sneer at and ridicule the scientific work of the present day because it seems to you useless?

Tells us a better method of observation; give us better suggestions as to what these magnetic phenomena may mean; but the past record of scientific observation enables us to laugh at you when you say that magnetic observations may never give the world any important results. Was Nature ever so open and yet so closed about a secret as she is about this one of terrestrial magnetism? Was there ever one whose revelation promised so much? How very little we know of electricity and magnetism! Does the mere motion of the earth, taking no account of electric charges at all, cause it to be magnetic? Almost anything is on the cards. Surely I need not appeal to your cupidity, but it is quite possible that our knowledge of this secret may enable us to tap a tremendous store of Nature's energy.

Gentlemen, this is not a trades union, and it is not a society for the furtherance of pure scientific research, but it is a society of professional men who recognize the past services of scientific observers with gratitude and respect, and hope for greater ones in the future. And shall it be said of us that our gratitude is not greater than that of Judas, to whom indeed thirty pieces of silver was doubtless a large sum; that "we have given our hearts away a sordid boon"; and that as to our future hopes, we are willing to sell our birthright for a mess of pottage?

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

THE adaptation of clay to its manifold uses possesses a twofold interest to the engineer, from the ever increasing use of machinery for its treatment, and from the wide range of materials that are employed, after passing through a variety of processes to render them suitable for use in ceramic industry, and the coarser applications to building and sanitary purposes.

In reviewing the mechanical appliances connected with this industry, shown at the Exposition, the first and most striking fact that presents itself is that they are almost exclusively French; in fact, except for one German and one American exhibit, they are wholly French. Perhaps this is not a matter for much surprise as regards the higher order of ceramic machinery. In Europe, France takes the lead in industrial ceramics, and her large and increasing foreign trade has stimulated the inventor to perfect machinery that will increase production. In the United States the industry is still young, but is rapidly increasing, especially in the sanitary branches, as our manufacturers are beginning to learn to their cost. That Britain is entirely unrepresented is no matter for surprise; her part in the Paris Exposition is so unworthy of the country, and her industries, that the absence of ceramic machinery is only consistent with the rest of the unsatisfactory record. There is little doubt that the French manufacturers will be well repaid for their enterprise by the business that will come to them from all parts of the world; at all events, they well deserve this result, for the exhibits of this class are numerous, and of great interest. In the larger group of clay-working machinery is, of course, included that for the manufacture of bricks, tiles, pipes, etc. In this branch of the industry Britain can certainly claim to take a leading place, both in the home and foreign trade; it is all the more to be regretted, therefore, that those responsible for the success of British participation did not secure a partial representation in these classes. Regrets, however, are unavailing, though the consequences may be far-reaching.

We propose to describe briefly the more important machines exhibited, according to the purposes they serve. From Limoges come the appliances employed in ceramic products, properly so called, domestic pottery, such as plates, cups, dishes, basins, etc.; the other machines are for the preparation of material and the manufacture of bricks, tiles, pipes, and so forth.

Machines for Preparing Clay.—Commencing with the last named series, the preparatory machinery first claims attention. This comprises crushing, mixing, pugging, and other mills, which bring the clay into a fit condition for the brickmaking and other machinery. It is to be regretted that space in the Exposition is so limited that no manufacturer has been able to send a fully representative collection, but only type machines, dealing with the means of production, and not with products.

The preliminary operations to which clay is subjected vary with the nature of the material, and the purposes for which it is destined. A certain class of excavating machine for the soft non-stony clays peculiar to the neighborhood of Paris are not shown at the Exposition. The same remark applies to the cylindrical crushing mills, which break up the hard nodules, stones, etc., common to most clays. These machines possess no special features, and occupy much space; their absence, therefore, is readily accounted for. On the other hand, we find several types of vertical mixing machines; one of them is shown by M. Joly, of Blois, and is illustrated in Fig. 1. It possesses the usual features of the type; a vertical cylinder in which is a vertical shaft driven by gearing, and armed with a series of blades for cutting and mixing the clay, which is discharged through an opening below. The cylinder in the Joly machine is of wrought iron; in other examples it is cast. A large pugging mill of a similar type is shown by MM. Pinette et Cie.; this machine, which is intended for treating hard clays, requires a 12 horse engine to drive it. The machines shown by MM. Delahayes et Cie., of Tours, present an additional feature. One is illustrated in Fig. 2, where it will be seen that a pair of crushing rolls are placed on top of the mixing cylinder; the clay is fed from a hopper between these rolls, and any hard substances present are crushed before delivery to the revolving knives.

In the preparation of ceramic clay, it is often necessary to reduce to powder the dried clay itself, as well

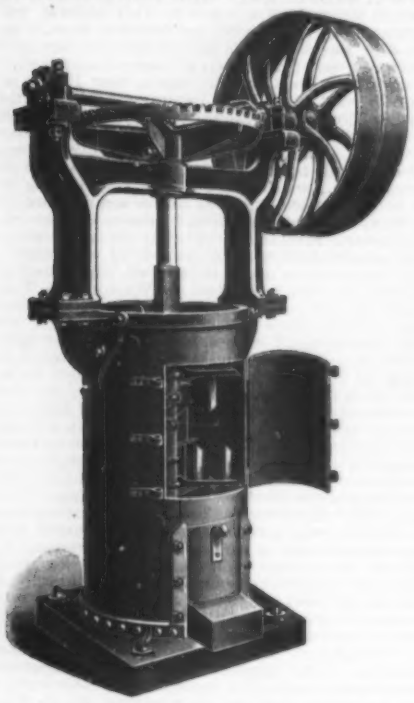


FIG. 1.—PUG MILL CONSTRUCTED BY MM. JOLY ET CIE., BLOIS.

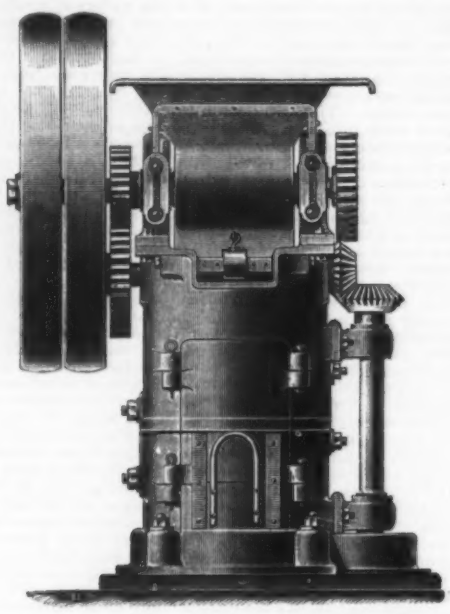


FIG 2.—PUG MILL WITH CRUSHING ROLLS, CONSTRUCTED BY MM. DELAHAYES ET CIE., TOURS.

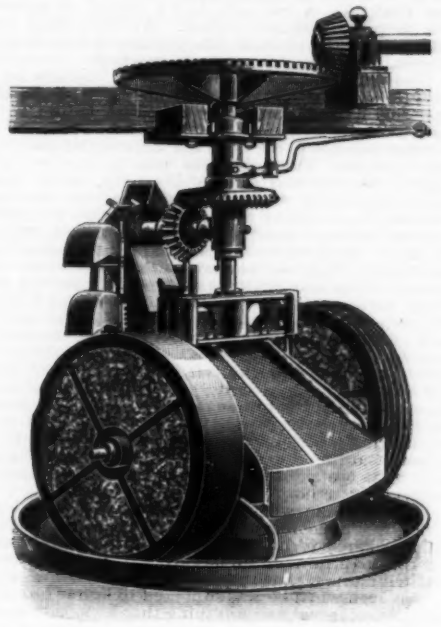


FIG. 3.—CRUSHING MILL WITH CENTRAL SCREEN, CONSTRUCTED BY MM. JANNOT ET CIE., TREIL.

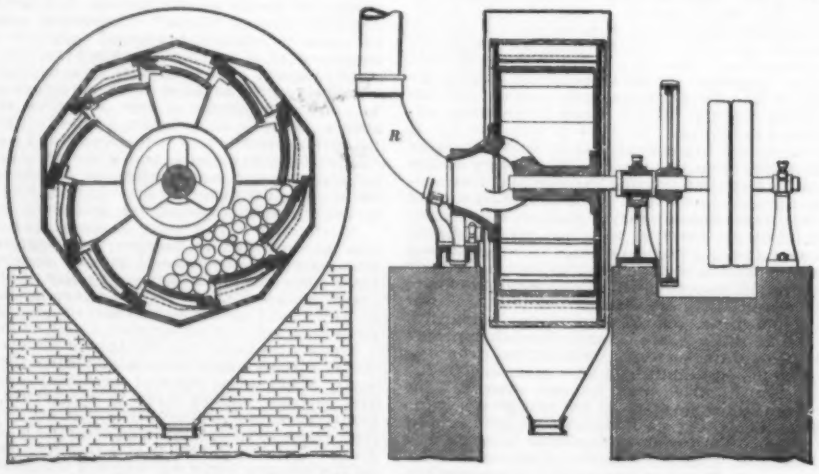


FIG. 4.—BALL-GRINDING MACHINE CONSTRUCTED BY MM. DAVIDSEN ET CIE., PARIS.

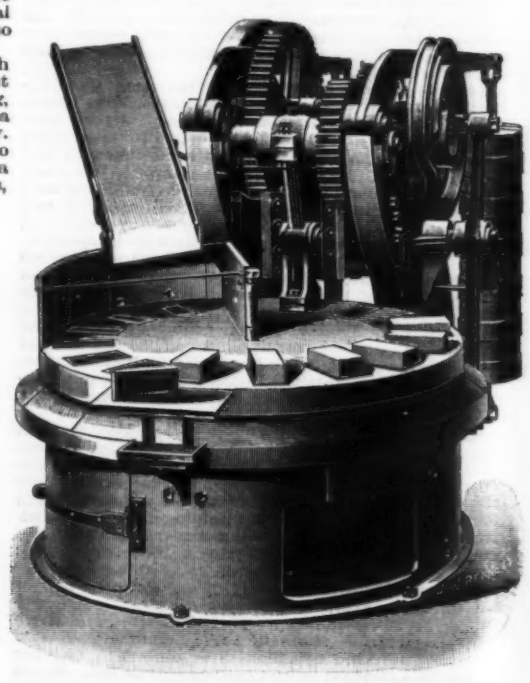


FIG 5.—PRESS FOR SILICIOUS BRICKS CONSTRUCTED BY MM. PINETTE ET CIE., CHALONS-SUR-SAONE.

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

supplemented by drawings, photographs, and catalogues of others for which it was impossible to find space. The greater part of these machines and their products belong to Class 72; they are exhibited in the buildings on the Esplanade des Invalides, where such few examples of ceramic art, domestic and sanitary pottery, as have been sent by Britain are also collected; these do not interest us, however, as we are as the other materials which enter into the composition of the paste flint, bone, etc. The most generally used type of machine of this class in France is the edge runner mill, of which a good example is shown by MM. Jannot et Cie., of Treil (Seine et Oise), among a quite remarkable display of clay-preparing machines. The crushing mill consists of a pan, two edge runners, an endless bucket chain, and an inclined screen, together

with the necessary heavy gearing to drive the various parts.

Fig. 3 shows the design of the machine, except the means of removing the fine crushings from the pan; the pieces that cannot pass the meshes of the sieve fall back beneath the rolls. These mills require from 2 to 5 horse power to drive them, according to the hardness of the material to be crushed. Near the Jannot exhibit are some crushing mills on the Smidth system, made and shown by Davidsen, of Paris. The hard material to be treated is placed in the hopper of a stone breaker, and is crushed and screened in one operation; the larger pieces being returned automatically to the hopper and passed repeatedly through the machine.

Fig. 4 illustrates one of this firm's ball-grinding machines. This is a casing with a discharge hopper beneath; the casing contains a revolving breaker with ten segmental arms arranged as shown, so that there is a space between the ends of each adjacent segment. Through these spaces and through openings in the segments, both properly screened, the pulverized material falls into the hopper beneath. Crushing is effected by means of a number of hard balls; the material to be pulverized is fed through the pipe, *R*, into the center of the drum, and as this latter slowly revolves, it is crushed by the action of the balls. As it becomes fine enough to pass through openings, it is collected as explained above, the larger parts being carried upward by the motion of the drum until they fall back upon the balls and are again subjected to their crushing action.

Brickmaking Machinery.—Examples of both classes of brickmaking machinery, by pressure and forcing through dies, are exhibited by French makers at Paris. Of the first kind there are several examples; it is not a system much employed in France, except for special purposes, such as the making of refractory bricks—silicious, bauxite, etc. The clay is previously pulverized, then compressed in molds in an hydraulic press; the Lys-Tandre house of Lille exhibits one of these machines; and that shown by MM. Pinette et Cie., of Chalons-sur-Saône, and shown by Fig. 5, is also an illustration of pressed brick machinery. This machine possesses all the ordinary features of its class; the revolving table with molds, the rising and falling bottoms of which are operated by cams; the compressing devices and the heavy gearing.

The machines of which examples have been selected are for making brick from pulverized clay or other material. There is, however, another type to be mentioned, in which the clay is moistened. These are all of a small pattern, and are worked by hand; they are very largely used in the numerous brick works throughout France.

Fig. 6 shows a machine of this kind constructed by MM. Boulet et Cie., and shown in Class 114 (Colonies) at the Trocadero. Primitive as this machine appears, it is of great utility. The illustration explains itself. The previously prepared clay is placed in a double mold, either of brass or steel, made with a moving bottom; when the molds are filled, the cover, shown open in the illustration, is closed and held by a powerful stirrup. The long hand lever is then pulled over, the power exerted being transferred to the bottom of the molds; the clay is thus compressed, and the cover can be lifted, when the finished bricks are raised from the molds by a pedal that lifts the bottom level with the top of the molds. Two men are required to work this press, with which they can produce from 300 to 400 bricks per hour; the clay used is made slightly plastic before being placed in the molds. An American brickmaking machine, sent by the Bucyrus Clay-working Machinery Company, of Ohio, and illustrated in Figs. 7 and 8, may be mentioned here. It is an upright stock brickmaking machine and pug mill combined, and is, of course, for soft clay, imitating the process of hand-making by delivering the clay into wood molds, removing the excess, and placing the soft bricks on tables to harden.

Fig. 9 shows one of the molds; from this figure it will be seen to be made in several compartments. The clay is finally prepared in the pug mill shown in the illustration; from this mill it passes into a vertical cylinder, and then through *P* and the opening, *m*, above the multiple mold. A plunger, moved by the rod, *F*, compresses the clay in the molds; as soon as this is done, a cam shifts the molds out of position, and brings another set beneath the plunger. There are some ingenious details to insure the series of operations being consecutively performed. The degree of pressure exerted on the clay can be easily regulated by means of a pin connecting the rod to the crank arm; this is done by shifting the pin into one or other of the holes in the plate shown in Fig. 7. The capacity of this machine is from 2,500 to 3,000 bricks an hour, and 25 horse

FIG. 6.—LEVER BRICK PRESS CONSTRUCTED BY MM. BOULET ET CIE., BLOIS.

power are required to work it, 15 horse power for the machine and 10 horse power for the pug mill. We are indebted to London Engineering for the above description and the engravings.

FIG. 9.

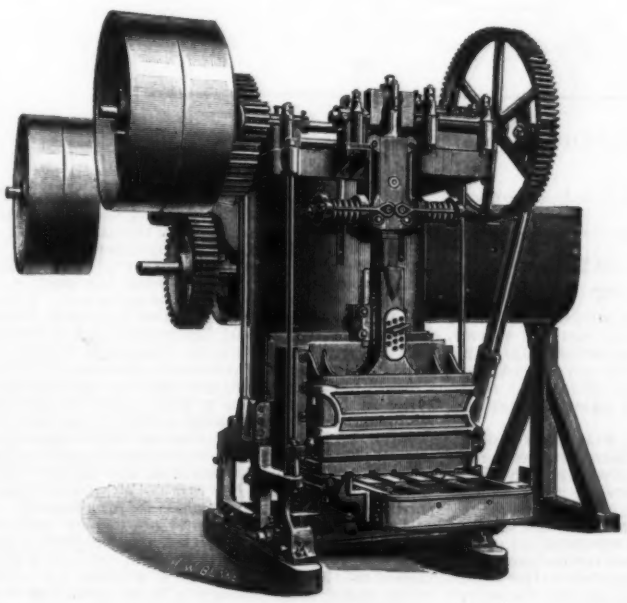


FIG. 7.

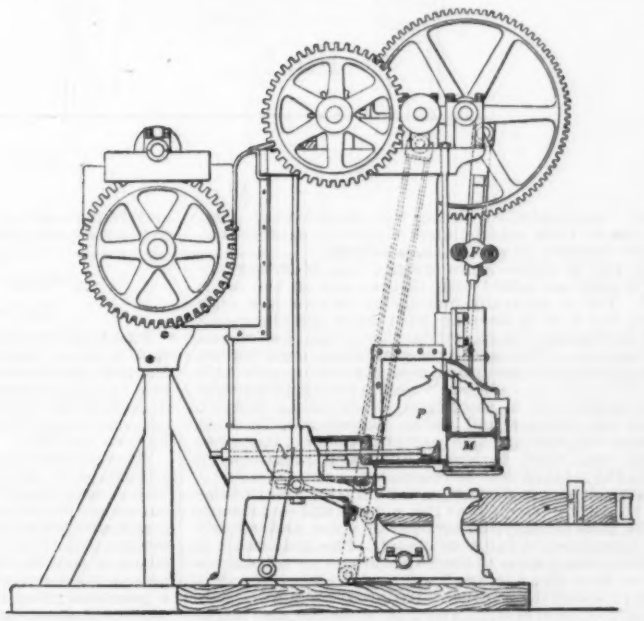


FIG. 8.

FIGS. 7, 8, AND 9.—BRICK-MAKING PLANT CONSTRUCTED BY THE CLAY-WORKING MACHINERY COMPANY, BUCYRUS, OHIO, U. S. A.

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

IDENTIFICATION OF FIBERS.

WHILE a great deal has been published on the identification of the different fibers in commercial use, much of this has not had a truly commercial aspect. It is frequently difficult to identify a fiber from the description given in commercial text books, especially where fibers closely resembling each other are examined under a microscope after the ordinary treatment or mount.

A writer, in speaking of the microscopical identification of some useful fibers, says that the separation of the ultimate fibers by teasing is tedious, and often leads to a very unsatisfactory mount. The best way is to remove by chemical treatment the resins cementing the ultimate fibers into the filament. This is more difficult with some fibers than with others, those having a high content of silica being usually the most refractory. In this particular, sisal and manila are the most noteworthy.

In a commercial laboratory, where results should be obtained as quickly as possible, a quick temporary mount has to be made which will show the characteristics of the fiber necessary for identification; and in order to prepare the fiber for such a mount, a suitable chemical treatment not occupying too much time is a great desideratum. The best method consists in boiling the fiber in a two per cent. solution of caustic alkali, washing and suspending the fiber in water, and passing a stream of chlorine gas through it until it is thoroughly bleached and the gums thoroughly destroyed. This may also be done by placing the specimen in a solution of chlorate of potash acidified by hydrochloric acid. At this stage the filament is entirely destroyed, but the ultimate fiber retains the form of the filament. The material is then rinsed in alcohol, and mounted in Canada balsam in the usual way. After this treatment there should be no difficulty in teasing out the ultimate fiber.

The fiber may then be examined under a microscope or micro-photographed. The best method for the examination of fibers is with artificial light, using a polarizer. The joints or markings on the fiber seem to have a different rotatory power, or at least they are brought into a more distinctive effect in relation to the rest of the fiber. This is also true in photographing, and the best photographs have been obtained by using an arc light and polarizing the rays. The markings are more distinctly brought out when the analyzer and polarizer are in such relative positions that the background or field is almost totally dark.

To distinguish between sisal and manila is one of the hardest problems of fiber identification, but little trouble has been found after treating the fibers in the manner described above.

The characteristic appearance of manila is very much enhanced by the chlorine treatment, and the same is true of sisal. The sisal is very much coarser than manila, and tapers considerably more; when properly prepared the dark center is seldom apparent. It has, however, after the treatment mentioned above, peculiar markings, having transversal cross-markings which appear to form X's upon the fiber.

The peculiar formation of the cotton fiber is so distinctive as to need no comment. Wool, with its peculiar scaly appearance, is also very distinctive, and where wool and cotton are found together they are readily distinguished by an ordinary mount. The above treatment has never been tried on animal fiber, for the reason that nothing would be gained.

Silk is also distinctive; it is quite even, but occasionally little nodules are noticed in the side of the fiber, and for this reason it is not as regular in width as manila. It has apparently no markings, and its ultimate fibers are also its filament.

Among the textile fibers the most difficult to distinguish one from the other are flax and ramie. They are used in the same class of work, when ramie is used at all, and have the same general microscopical appearance. Ramie, at first sight, looks very like flax, although, upon a minute examination, a difference will be observed. The ultimate fiber of ramie is usually coarser, the bamboo-like joints are larger and more marked, and have quite a different appearance from that of flax as seen with a moderately high-power glass. —Textile World, Boston, Mass.

CORN OIL: ITS CONSTITUENTS, PRODUCTION AND USES.

AT the present time, says The Paint, Oil and Drug Review, of Chicago, the qualitative constituents of corn oil, its production and uses, together with the possibilities of its adaptation and extension as an industrial product, make the oil derived from Indian corn a much-talked-of article of commerce. We have previously described the method of separating the oil germ from the starchy body of the corn and will not repeat the details of this process. A manufacturer of starch tells us that a bushel of corn produces on an average 2 pounds of germs, from which 1¼ pounds of oil can be expressed.

Corn oil has a bright golden color, it has a somewhat peculiar "starchy" odor, and its taste is mild and not unpleasant. Its specific gravity at 10° C. is 0·9269, at 15° C. 0·9244, and at 20° 0·9219. The mean coefficient of expansion between 10° and 20° is 0·000706. Schaedler gives the specific gravity at 15° as 0·9315, and Mills

states that in 1884 he found a rather coarse sample to have a specific gravity of 0·965. When exposed to intense cold the oil becomes turbid, owing to the decomposition of solid matter at 20°. The precipitated solid matter is entirely redissolved on warming again. The bromine and iodine absorptions were: Bromine absorption, 66·50 per cent.; iodine absorption, 122·90 per cent. A thick, dark-colored sample was found by Mills, in 1881, to have a bromine absorption of 74·42 per cent. On saponification with alcoholic potash, the total KOH absorbed is 19·34 per cent., which gives a saponification equivalent of 290·07. The oil is readily saponified in the cold. An English contemporary states that the higher fatty acids present in corn oil seem to present no unusual features, but exact determinations as regards the proportion in which they are severally present have not been made. The volatile fatty acids, separated by Reichert's distillation process, for 100 parts of the oil required for their neutralization 0·56 part of KOH.

It should be noted that a tendency to oxidize or to gum is almost absent in this oil while in its natural state, and no decided siccative properties are communicated to it by simply boiling or by the addition of litharge to it. On passing a current of air through it for an hour at a temperature of about 150° C., the oil becomes slightly darker in color, and rather more viscous, but by no means to the same extent as cotton oil. If to the oil so treated a small quantity of borate of manganese is added, the oil acquires to a small extent siccative properties, and a thin film on the lead dried in from ten to twenty hours, but not completely, being tacky to the touch at the end of that time. Like cottonseed oil, the elaidin reaction gives rise to a mass having a pasty or buttery consistency. But it is claimed by parties at Buffalo, N. Y., that the problem of eliminating the non-drying ingredients has been solved — accomplished during the present year — and that the oil thus manipulated is made to exhibit even greater siccative properties than linseed.

The rise in temperature when 5 c. c. of strong sulphuric acid are mixed with 15 grammes of the oil is 79° C. For a naturally non-drying oil this is a high figure, but it is in keeping with what may be called the "tenderness" of this oil in the presence of chemical reagents. The so-called qualitative tests for oil with sulphur acid and nitric acid, etc., fail to give with corn oil reactions sufficiently characteristic to warrant their application in identifying or detecting this oil. Hence its bromine and iodine absorptions, its high Maumene figure, and the ease with which it saponifies in the cold, must be looked upon as the features by which the oil may best be recognized.

A soap expert in discussing the industry and its relation to corn oil states that the potash and soda soaps are of good quality, being light in color, and readily and completely soluble in water. The soda soap is distinctly the harder of the two, but the potash soap is harder than the average "soft soap." Soapmaking is a use to which the oil has up to date been most largely applied. The ease with which it saponifies also might make it useful to mix with other oils, to accelerate the saponification. But it must displace cottonseed oil, which gives a perfect saponification as against an 80 per cent. result with corn oil. So it is always a question (in corn oil) of economy, the price determining which oil shall be utilized. Of the production in the United States, about 18,000 barrels per month at the present time, German soapmakers take about 75 per cent.

As a lubricant, corn oil might, in certain cases, be applicable, its low acidity and its very slight tendency to deposit solid matter or to "gum" being properties that recommend it for this purpose. The oil dissolves readily in acetone, and more sparingly in alcohol or glacial acetic acid. This viscosity was determined roughly by observing the time of flow of 5 c. c. of the oil through a burette, with a capillary point, and comparing the results with standard oils:

	Corn.	Olive.	Colza.	Mineral.
Specific gravity	0·925	0·918	0·915	0·910
Time of flow	177·3"	244·5"	200·0"	13·59"
Viscosity (Colza=100)	61·1	84·3	100	83·9

From the foregoing it will be observed that corn oil possesses a striking individuality. In general, it may be said that in properties it is somewhat akin to cottonseed oil. At the same time, there are differences between them which are primary and radical.

The Drugs, Oils and Paints, of Philadelphia, says: The interest in corn oil as an alternative for linseed oil in paint manufacturing, when linseed oil is deterrently high, is great and widespread. The manufacturers of corn oil profess to know that some paint manufacturers are using it successfully, but the process of preparation and manipulation employed for making it dry satisfactorily are said to be trade secrets, zealously guarded by those who have discovered them.

One correspondent mentions a refined corn oil offered for his inspection which dried on glass nearly as rapidly as raw linseed oil, and this sample is now under examination. The probability is that the success obtained is usually more or less commensurate with the proportion of linseed oil with which the corn oil is mixed.

We have less chemical knowledge of corn oil than is desirable where attempts are making to convert it into available drying oil, and the manufacturers of the product might do themselves and the paint trade a good turn by setting their chemists at work to determine not only its properties and chemical constants, but its molecular constitution. We want to know the easiest and deepest method of turning its high iodine number to practical account.

FIG. 3.

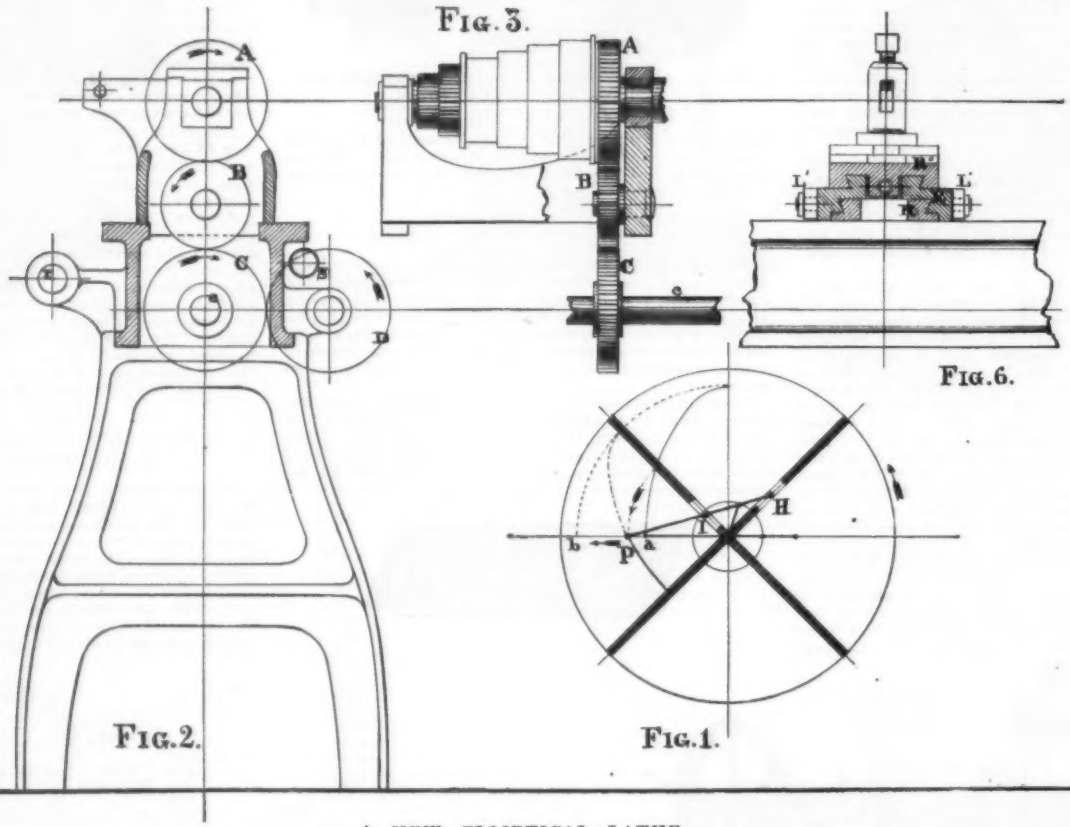


FIG. 6.

FIG. 2.

FIG. 1.

A NEW ELLIPTICAL LATHE.

A NEW ELLIPTICAL LATHE.

By Prof. C. W. MACCORD.

THE lathe for elliptical turning, of which a description is given below, possesses several entirely novel features which render it capable of performing with ease and in a superior manner not only all that can be done with the appliances hitherto introduced for that purpose, but also work which can not be executed at all by their aid alone.

The ordinary elliptic chuck, as all who have used it are aware, is open to one or two serious objections. These have their foundation, moreover, in the very nature of the device, which in one important particular is radically defective. In turning an ellipse, the tool is set at a definite and fixed distance from the axis of the lathe, so that the whole piece to be operated on must receive the compound motion by which the desired form is produced; it cannot, then, be supported on the back center. Consequently it must be held, by one end only, in a common chuck which again is screwed upon the projecting nose of the elliptical chuck. If the piece be long, then the work is liable to spring away from the tool; and if heavy, the overhanging weight produces an injurious strain upon the mechanism of the chuck itself, so that the range in length is quite limited. Another objectionable feature of this compound motion is that the work is not in running balance; at high speeds this tends to cause a vibration of no benefit to either chuck or lathe, and at any speed it is unfavorable to the production of fine and accurate work.

In the lathe herewith presented to notice, on the other hand, the work is mounted and driven and supported on both centers, just as in the ordinary turning of a round shaft, and its only motion is that of revolution about its axis of symmetry, being therefore in perfect running balance; and the elliptical section is produced by an automatic cross-feed movement of the tool holder, which travels in and out upon the slide rest while the latter is driven longitudinally by the lead screw as usual, so that an elliptical cylinder of any length can be turned as readily as a circular one, and with the same degree of accuracy. The manner in which this is accomplished will be understood by aid of the accompanying illustrations; which, it is to be kept in mind, are intended solely to exhibit the principles and mode of action, as no attempt is made to observe the proportions, or actual arrangement of details, of a working machine.

The fundamental "mechanical movement," or combination, from which the required motion of the cutting tool is derived, is shown in the diagram, Fig. 1. We have here a disk in whose face are two slots at right angles to each other, and a block sliding freely in each slot; to these blocks the bar *P I H* is pivoted at *H* and *I*. Holding the disk still, and moving the bar, this is at once recognized as the familiar elliptograph, the point *P* tracing the curve upon the disk. Now let the disk be pivoted at its center upon a fixed pin, and let the free end *P* of the bar be constrained by guides to travel along the horizontal center line. Then as the disk goes round, *P* will traverse, back and forth, the path *a b*, equal to *I H*, the difference between the semiaxes of the original ellipse. But the motion of *P* relatively to the disk is the same as before; and it follows from this that a pencil fixed at that point in the bar would trace the same ellipse as before upon a disk rotating in contact with it about the same center, in either direction, with the same angular velocity. For the rotating disk, substitute the piece mounted in a lathe, replace the pencil by a cutting tool, and the desired result will be accomplished.

Fig. 2 is a transverse section of the headstock and bed, and Fig. 3 a side view of the headstock, partly in section. *A* is the wheel fixed on the mandrel; it drives another wheel *C* of the same diameter through the intervention of the idler *B*, which turns upon a pin fixed in the headstock. *C* is keyed upon the shaft *c*, whose bearings (not shown) are in the lathe-bed. This shaft *c* runs the whole length of the bed, and projecting through the remote end, has keyed upon it a wheel *C'*, seen in Fig. 4, which is an end elevation, looking in the opposite direction. *C'* drives another wheel *D* of equal size, supported by a bracket fixed to the bed, and carrying on its outer face a disk, which is slotted, and provided with sliding blocks to which the bar *P I H* is pivoted, all as in Fig. 1. This bar *P H* is here shown as sliding through a socket, which by means of a binding screw can be clamped upon it at any desired position, so that the ratio of *P I* to *P H* can be varied at pleasure, thus making the adjustment for eccentricity. This socket is pivoted to another one, which in a similar manner can be clamped to an arm projecting upward from the piece *E*, which slides in vertical guides attached to the frame. To *E* is pivoted the lever *F J*, which slides, *first*, through a block pivoted at *G* to another block capable of horizontal adjustment at any required distance from *E*, and, *second*, through a block pivoted to the vertically sliding piece *K*. Thus the velocity ratio between the motions of *E* and *K* is perfectly constant, but while the actual traverse of *E* is always equal to *I H*, that of *K* will be greater or less according to the position of *G*.

The motion of *K* is transmitted by a link *L* to a lever *M*, keyed upon a rock-shaft *r*, supported in brackets fixed to the lathe-bed. This rock-shaft runs the whole length of the bed and parallel to it, passing freely through a downward projection of the slide-rest *R*, as best seen in Fig. 5, which is a transverse section; it is longitudinally slotted for the reception of feather-keys fixed in the curved levers *N N*, which slide upon the

rock-shaft, but vibrate with it, their angular motion being the same as that of *M*. These levers have turned projecting hubs, fitting into corresponding recesses in *R*, having thus in effect bearings in the slide-rest itself, and are confined by the bracketed piece *Q*, bolted to the downward projection above mentioned, as best seen in Fig. 8, which is a top view, and in Fig. 9, which is an end view, of the lower part of the slide rest: thus the latter carries the vibrating levers with it as it travels along the bed.

The slide-rest is made in three parts, as shown in Figs. 4, 5, and 6, the latter being a vertical section by a plane parallel to the axis of the lathe. The lower, or main piece *R*, which slides lengthwise on the bed, is fitted with the usual apron and attachments for feeding either by hand or by the lead-screw *s* (Figs. 1 and 5)—all of which are omitted in the drawing. The second piece *R'* is fitted to slide upon *R* across the lathe-bed, and receives its motion from the levers *N N* by means of the two links *L'*, *L*. Above this again is the third piece *R''*, which finally carries the tool-holder *T*. *R''* also slides upon *R'*, perpendicularly to the axis of the lathe, and by means of the ordinary screw and handle, a cross-feed motion is thus provided, independent of the motion of *R'*; the use of which will appear later on.

Now returning to Fig. 4, it is to be understood that the lines drawn from the center of the rock-shaft *r*, through the centers of the pins in the ends of the levers *M* and *N*, are at right angles to each other; also, the levers are of the same length, the link *L'* is of the same length as *L*, and the arrangement is such that when

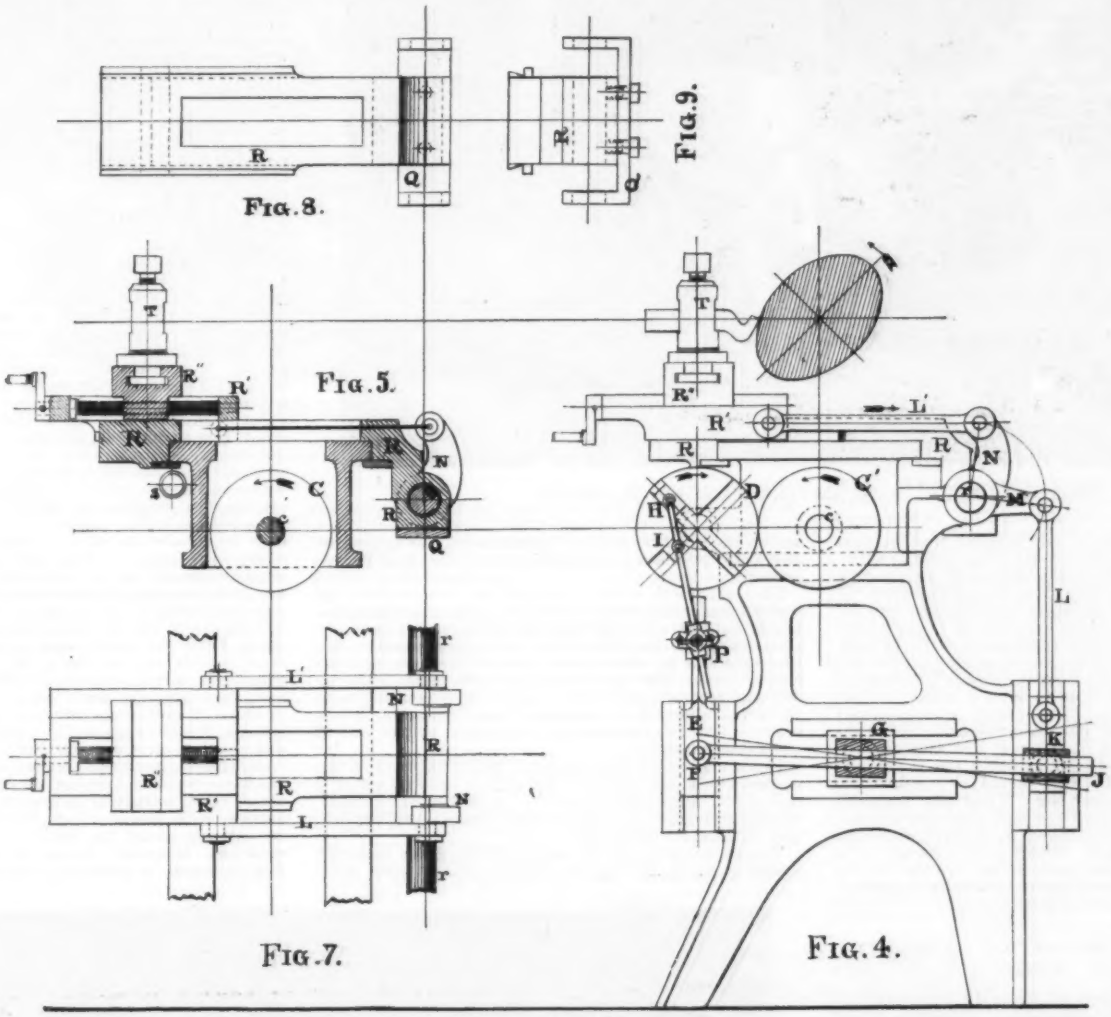


FIG. 8. FIG. 9. FIG. 5. FIG. 7. FIG. 4.

A NEW ELLIPTICAL LATHE.

the latter is vertical the former is horizontal. Consequently, any error introduced into the motion by the angular vibration of *L* is neutralized by the corresponding vibration of *L'*, so that the movement of *T* in a horizontal direction is at every instant precisely the same as that of *K* in a vertical direction.

To facilitate the adjustments, provision should be made for locking the wheel *D*, Fig. 4; preferably when *H* is at its lowest point, at which instant the bar or connecting-rod *P H* will be vertical: then by the means already described, the two sockets can be so placed that the ratio of *P H* to *P I* shall be the same as that of the major to the minor axis of the required ellipse; which completes the adjustment for eccentricity.

But the vertical traverse of *E* is always equal to *I H*, while the actual travel of the tool must be equal to the linear difference between the semi-major and the semi-minor axis of the required ellipse: *G* must therefore be so placed that the vertical traverse of *K* shall be equal to that difference: in other words, when the lever *F J* is horizontal, we must have *E G* : *G K* :: *I H*: given difference of semi-axes. At the instant mentioned, *R'* will be at the extreme outward limit of its travel, the major axis of the ellipse to be turned being horizontal; and the distance of the point of the tool from the center line of the mandrel must be equal to the semi-major axis. This is adjusted by means of the independent hand cross-feed, by which *R''* is moved to the required position: and a movable stop, not shown, should be provided, and now clamped to *R* to prevent the tool from being fed farther in. It is now in position for the finishing cut; for the roughing cuts it may be moved farther out, when it will produce a symmetrical but not truly elliptical section, gradually approaching the latter as it is fed in by hand, and reaching it when *R''* is brought up against the stop; after which the automatic feed completes the work. It should be added that it is also essential to set the tool, just as in turning a cone in the common lathe, with its point in the same horizontal plane with the axis of the mandrel, and neither higher nor lower.

The lathe as here shown would seem adapted for outside turning only; but it is to be recollected that these are not working plans, and by extending the part *R'* of the slide-rest, the tool holder may be so placed as to adapt it for inside turning to a limited depth: but to at least as great a depth as is practicable with the elliptic chuck, while the work can be done to greater advantage on account of the steadiness of the motion.

It may be said that the construction demands the most perfect workmanship, which is true, but no more true of this than of many other machine tools for special purposes, and, in fact, no more true than it is of the elliptic chuck. If it be urged by way of objection that there is but little demand for work of this kind, there are two things to be said in reply; one is, that this may be due in part to previous difficulties in executing it; and the other is, that this lathe need not stand idle for the lack of elliptical work. For, by simply locking the wheel *D* and removing the idle wheel *B* or sliding it out of gear, we have an ordinary lathe which may be continuously employed, like any other, on circular work—all of which again calls attention to the fact that should occasion require, a piece once hung in this lathe may be made circular in one part and elliptical in another without unmounting, as for instance in forming an elliptical cam on a round shaft, something quite beyond the power of the elliptic chuck or of any analogous device previously employed.

IRRIGATION FOR THE EAST.

THE Office of Experiment Stations of the United States Department of Agriculture will soon issue Bulletin No. 87, entitled "Irrigation in New Jersey." It was prepared by Prof. E. B. Voorhees, of the New Jersey Experiment Station, and describes his experiments in irrigation for the season of 1899. It is generally thought that the necessity for irrigation in the United States exists only in the region west of the Mississippi River, but repeated crop failures in the East and successful farming in the West have called attention to the importance of controlling the moisture of soils rather than accepting the conditions as they exist. Prof. Voorhees estimates the loss to the hay crop of New Jersey from the drouth in May and early June, 1899, at $1,500,000, while small fruits and vegetables were even more seriously affected than the grasses. The records kept by him at the experiment station show that "in 1897 and 1898, years of abundant rainfall in April and May, the yield of hay averaged 2·65 tons per acre. In 1899 it was but a fraction over 1 ton, owing to the deficiency of rainfall in April and May, at the low price of $10 a ton, a loss for the 25 acres of over $400. The yield of crimson clover forage for 1897 and 1898 was 8·5 tons per acre; in 1899 the yield was but 5 tons, or in a good year the yield was 70 per cent. greater. The deficiency in the rainfall at the critical period was alone responsible for this difference in yield. Oat and pea forage in 1897 and the early seeding of 1898 averaged 6 tons per acre; in 1899 the yield was but 3·3 tons per acre."

To show the frequency of such drouths as that of 1899, the bulletin cites the rainfall records of Philadelphia: "The rainfall records in Philadelphia from 1825 to 1895 (70 years) show that in 88 per cent. of the years there was a deficiency of over one inch for one month, or that in 62 years out of the 70 there was one month in the growing season from April to August in which such a marked deficiency occurred as to cause a serious shortage of crop, and that for the same period there were 39 years in which the deficiency extended throughout two months, while in 21 years it extended throughout three months, or in 30 per cent. of the years included in this record there were three months during the growing period in which the average rainfall was deficient one inch or more. It is thus observed that a wide series of crops would be likely to suffer in more than one-half of the years for which the record is available, while a still larger number would suffer in nearly one-third of the years, for it must be remembered that even a slight deficiency in one month may result in serious reduction in yield and consequent loss if it occurs at a time when the crop is making its largest development."

The experiments conducted by Prof. Voorhees and reported in this bulletin were for the purpose of determining whether irrigation during these short periods of drouth would result in sufficient increase of yield to pay for the works necessary to obtain the supply of water. The tests were made on small fruits. Careful records were kept of the yields of plats, which received identical treatment, except that some were irrigated and others were not.

The yields of the irrigated plats over and above those not irrigated were as follows: Blackberries, 1,038 quarts per acre, worth $93.42; raspberries, 329 quarts per acre, worth $32.90; currants, 852 quarts per acre, worth $85.20. The increase in yield would not be so marked every year as in 1899, as the drouth of that year was exceptional.

The bulletin contains detailed descriptions and statements of cost for a number of small irrigation plants in New Jersey. All of these are pumping plants. The cost of plants large enough to supply 10 acres of small fruits and garden crops has varied from $230 to $500. Records of the returns from these plants have not been kept, but the owners are all satisfied that their installation has been very profitable, and in nearly every instance have stated that they have made the cost of the plant in the increased crops the first year.

So far as climatic conditions are concerned, New Jersey may be considered typical of the whole eastern half of the United States. Judging from the results reported in this bulletin, there is no question but that irrigation for fruits and market gardens, even in regions of abundant rainfall, is a profitable undertaking.

The work in New Jersey is a part of an investigation of the problems of irrigation now being carried on by the Office of Experiment Stations in different regions of the United States. Owing to the greater importance of irrigation in the West, where farming is impossible without its aid, the greater part of the work is being

done there—Cheyenne, Wyo., being its headquarters. The results in New Jersey show that no agent of agriculture or horticulture is more effective than water, applied when needed, and that the Eastern farmer can well afford to pay more attention to the subject.

AN AUTOMOBILE MOWING MACHINE.

AT the present time automobiles consist almost entirely of carriages or delivery wagons, with occasional novelties such as fire trucks, ambulances, etc. There is, however, an enormous future for horseless farm machinery, and when farmers realize that their machinery can be propelled as efficiently as by horses at less expense by hydrocarbon motors, it will open a vast field

THE McCORMICK AUTOMOBILE MOWING MACHINE.

for manufacturers, and it is not strange that makers are already giving their attention to exhaustive experiments. Our engravings show a combined automobile mowing machine exhibited at the Paris Exhibition by the McCormick Harvesting Machine Company, of Chicago. The motor is a double cylinder, 10 horse power gasoline engine. The oil tank is divided into three compartments, one for oil, one for batteries and one for water. Power is transmitted from the motor by sprocket wheels and chain to a friction clutch placed on the cross-shaft of the mower. This clutch is so arranged as to engage either one bevel-gear wheel or another placed on each side, and in this way the machine can be run backward and forward, at will. The bevel-gear wheels engage a pinion, which serves to operate the fly-wheel shaft and cutter-bar. They also transmit power to the mower-wheels through two gear-wheels. The friction-clutch is controlled by a lever placed at the foot of the operator. Steering is effected by a crank connected with the guide wheel in front of the cutter-bar. The cutter-bar can be lifted by the driver from his seat, by means of a lever.

PROGRESS OF IRRIGATION WORK IN THE WEST.

THE first progress report on irrigation investigations made by the Office of Experiment Stations, under the supervision of Elwood Mead, expert in charge, is in press and will be issued soon as Bulletin No. 86 of the Office of Experiment Stations, United States Department of Agriculture. It deals with the methods in use in the arid States in the distribution and use of water in irrigation, and gives a large number of measurements made to determine the duty of water; the losses from seepage and evaporation in canals; and describes the methods by which the water supply may be more effectively and economically applied to crops. It contains papers discussing the results of the year's investigations, by Elwood Mead, expert in charge; Clarence T. Johnson, assistant; and reports and discussions by special agents Thomas Berry, Colorado; W. M. Reed, New Mexico; W. H. Code, Arizona; W. Irving, California; R. C. Gemmell and George L. Swendsen, Utah; D. W. Ross, Idaho; Samuel Fortier, Montana; and O. V. P. Stout, Nebraska. It is illustrated by views, diagrams, and maps showing the location and character of the investigations made.

The investigations described deal with problems which sorely perplex the irrigators and canal builders of the arid West. Their comprehensive study is a new feature of national aid to irrigation development in this country. Heretofore the leading object of such aid has been to promote the construction of new canals, to show how much land there was above existing ditches which could be reclaimed, and the benefits which would come from such reclamation. It is believed that this investigation will tend to secure these ends, but its primary purpose is to promote the welfare of the people living under the ditches already built, to render the farms now irrigated more profitable, to lessen the controversies over the distribution of water, and secure its more systematic and economical use.

It is the opinion of those best informed that a better understanding of the existing situation must be had before we can plan wisely for future development. Controversies over the use of streams should be ended before an attempt is made to augment greatly such use. The claims to water, for existing and prospective ditches on many streams, amount in the aggregate to many times the supply. The character and extent of the rights now vested must determine what is to be done in the future.

Every transaction which has had to do with the disposal of streams has been marked by a lavish prodigality. Ditches diverted more water than was used; their owners claimed more than they could divert, while decrees gave appropriators titles to more water than ditches could carry and many times what the highest flood could supply. Little was known of the quantity of water needed to irrigate an acre of land, and in the absence of such information the ignorance and greed of the speculative appropriator had its opportunity.

The contracts which control the distribution of water from canals were framed by people to whom the whole subject of irrigation was strange and new. It often happens, therefore, that they do not promote the best interests of canal companies or meet the necessities of users. The laws which govern appropriations of water from streams have in most cases no relation to the actual practice of irrigators and, therefore, fail to secure either the systematic distribution or best use of the available supply.

Believing that a more general understanding of the causes which increase or diminish the duty of water is one of the most urgent needs of irrigated agriculture, the determination of this duty was made a leading subject of these investigations.

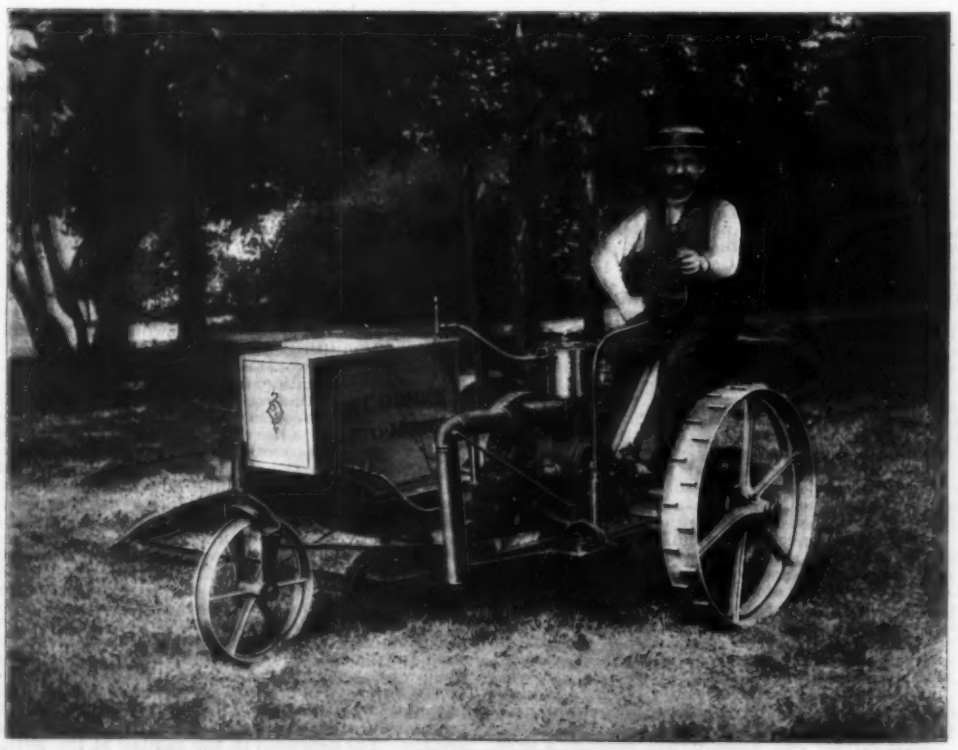
The report gives three tables showing the measurements of water flowing into large canals at their heads, another the water taken in by small canals and laterals, and the third the measurements of the water actually reaching the fields. The difference in results of the measurements at the three places shows the approximate loss of water in transit in canals. The results given are expressed in the depth to which the water measured would cover the land irrigated, provided it all reached the land. The table below gives the averages of the three classes of measurements:

	Depth (feet).
Measured at the heads of large canals.....	5·63
Measured at the heads of small canals and laterals.....	2·40
Measured at the margins of fields where used.....	1·29

The causes assigned for these losses are improper construction, the nature of the soil through which the canals pass, and the practice of placing checks in canals to throw water on land too high to be irrigated without their use. The report of the work on the Gage Canal, in California, shows that practically all of these losses can be prevented where the value of the water will justify the necessary expense. This saving would enable existing canals to irrigate double the area now reclaimed.

The most serious losses from evaporation do not occur in the main canals, but from the fields where water is distributed. During the midsummer season the continuous sunshine heats the surface of the ground to a very high temperature. A test made last summer showed the surface soil in Southern California to have a temperature of 120° F. When a thin layer of water is spread over land thus heated, as it is frequently done where flooding is practised, the loss from evaporation must be excessive. Mr. Reed discusses this in his report showing instances where it has become so great as to entirely absorb the volume supplied. Irrigators know by practice how much faster an irrigation head of water travels over fields at night and in the early morning than during the afternoon. This is due to the difference in the rate of evaporation. In order to lessen this loss it is important that fields be irrigated as quickly as possible. To do this each irrigator should be supplied with all the water he can distribute. Where only a small stream is used, progress is slow, the soil next the laterals is supersaturated; it is hard work to reach the high spots, while the low ones are over-irrigated by the delay this causes.

Contracts which provide for the delivery of a uniform constant flow are, as a rule, wasteful of water, and are not in the interest of either ditch companies or the public. Contracts which charge for the acres irrigated without regard to the volume used on these acres, are a temptation to extravagance on the part of the irrigator. On the other hand, contracts providing payment proportioned to the quantity delivered and for delivery in amounts which can be most efficiently distributed can not fail to lead to economy in the use of water and consequently to a high duty. Under such a system the irrigator is benefited by his saving and pays for his waste. Such contracts can be employed only in connection with a system of rotation in delivery to irrigators. This rotation benefits the canal company as well as the irrigator, because it lessens the loss from evaporation and seepage. If a canal is large enough to supply 100 farms, it will still supply them whether they are all irrigated every day or one-half given twice the usual supply every other day. On large canals the economy of such rotation is very great. It would permit of dividing canals in sections and supplying the lands under one section at a time. A canal 60 miles long could be divided into three sections of 20 miles each, and all the loss from seepage and evaporation on the lower forty miles saved while the irrigators of the upper section were being supplied. In the same way, by keeping the full supply in the canal, water could be rushed through to users under the lower section with less loss than where the flow is depleted by laterals along the route. The greatest saving in rotation, however, would be made in the laterals. Where water is permitted to dribble slowly through



THE McCORMICK AUTOMOBILE MOWING MACHINE.

continuously, the waste is enormous. By devising a system for grouping the laterals and inducing the irrigators therefrom to take water by turns, the engineer can do as much toward raising the duty obtained as the actual cultivator.

Owing to the requirements of the law limiting the publication of bulletins containing over 100 pages, only 1,000 copies will be printed, unless the demand is such that Congress sees fit to provide for a larger edition. There can be no distribution, therefore, to miscellaneous applicants.

TRANSFORMING APPARATUS AT THE EXPOSITION OF 1900.

AFTER the apparatus for the production of electric energy that we recently examined,* it will be of interest to make a brief study of the various other devices that serve for collecting the electric energy at the terminals of the electric machines, for transmitting it to a distributing board, and for conducting it to the points where it is to be utilized.

In this article, we shall confine ourselves to the transformation apparatus, the distributing board and the auxiliary apparatus, and say but a word or two about the wiring.

Instantaneous transformation apparatus for alternating, continuous or triphased currents were exhibited in great number, and it would be necessary for us again to mention all the manufacturers of electric machines, did we desire to render our article complete by speaking of all the transformers. In Fig. 1 we represent a few models of a new form.

In addition to these first transformers, we may mention rotary transformers, and commutators and converters of all models and all powers.

Afterward come the accumulators, which also are transformers. The number of accumulators at the Exposition was very great, and came from all countries; but the types found were based upon well known principles, and presented but little novelty.

However this may be, this simple enumeration shows us that the electrician possesses all the apparatus for changing and modifying the form of electric energy at will, for producing alternating, simple and polyphased currents, and for transforming these into each of the two other forms, either separately or simultaneously. And these apparatus are not for the use of the laboratory or for study, but are such as have already been utilized in numerous applications, and give very high industrial efficiencies.

When, at the works, we have transformed electric energy according to the requirements of the installation that we have in view, it is necessary that we shall be able to regulate the transmission of such energy at will, to distribute it in different circuits, to send it or arrest it, to measure it, to regulate the tension according to the discharge necessary, etc. This is the object of the switchboard, upon which are established all the apparatus that we shall presently enumerate. Our readers already know the composition of a switchboard, and so it is unnecessary for us to give a description of it. At the Exposition, we found some interesting models of it at several stands, not to mention the two large boards that serve for the total distribution.

The qualities that a switchboard should possess may be summed up in a few words: careful construction, plain and conspicuous arrangement of all the apparatus and irreproachable operation of all the apparatus.

We should naturally be led to examine all the apparatus of a board in detail; but we cannot do so for want of space. We can say, however, with great satisfaction that the Exposition showed us apparatus of all countries, but especially of France, Switzerland, and Germany (interrupters, circuit breakers, collectors, etc.), that were strongly constructed and presented all the qualities requisite for perfect operation. In addition to the large firms and establishments that have undertaken the manufacture of all kinds of electrical apparatus and that we mentioned in our article on dynamos, we may cite the Société Industrielle des Téléphones, MM. Vedovelli and Priestley, the Compagnie Française d'Appareillage Electrique, the Compagnie Générale des Travaux d'Eclairage et de Force, the Société d'Applications Industrielles, MM. Risacher and Hébert, Mr. Ellison, etc. In Fig. 2 we reproduce a few of teh apparatus; but we should have to describe thousands of them, were we to take all the remarkable specimens into consideration.

We must not forget to mention the indispensable measuring apparatus upon the switchboard or to cite the names of the manufacturers, J. Carpentier, Chauvin and Arnoux, Ducretet, Aron, Hartmann and Braun, Siemens and Halske, etc. In the class of meters we find the names of the greatest manufacturers of France and foreign countries.

Finally, we come to the distribution properly so called. As regards the line material, we remarked especially, at the Exposition, the André system of metallic poles for overhead lines and the porcelain insulators of the Société Anonyme des Anciens Etablissements Parvillée Frères et Cie.

As regards insulated cables, we were particularly impressed with the progress made in this line of manufacture, which is daily extending and daily producing new cables that are really superior to their predecessors and of great utility in the electrical industry. Among such we would mention the cables of Berthoud-Borel et Cie. de la Société Française, cables for tensions of 30,000 volts, the cables of the Société Alsacienne de Constructions Mecaniques, of the Compagnie Générale des Constructions Electriques, of MM. Geoffroy et Delore, of the India Rubber, Gutta Percha and Telegraph Works of Persan Beaumont, of the Allgemeine Elektricitäts Gesellschaft, of MM. Siemens and Halske, etc.

We ought also to pass in review the small apparatus and the cables for interior distribution, but shall have but a word to say upon this subject. At several stands we found new models of apparatus, or at least more carefully constructed models for obtaining tensions of from 110 to 220 volts at will.—For the above particulars and the illustrations, we are indebted to La Nature.

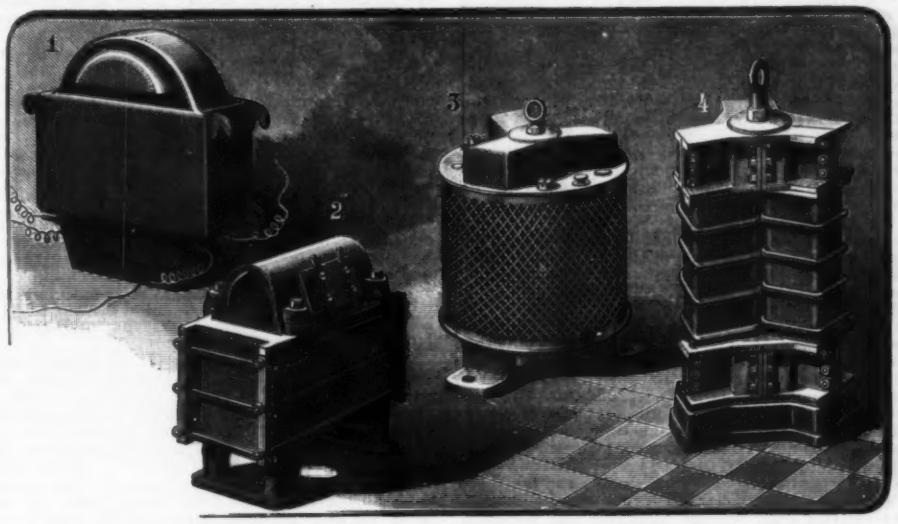


FIG. 1.—VARIOUS MODELS OF TRANSFORMERS OF ELECTRIC ENERGY.

1. Breguet transformer for distribution at a constant difference of potential. 2. Simple alternating current transformer. 3. Triphase current transformer. 4. Triphase current transformer.

* SCIENTIFIC AMERICAN SUPPLEMENT, No. 1296, page 20774.

Russian Demands for Phonographs.—The Bureau of Foreign Commerce has received a letter from Mr. Emil Rothstein, of Rostov on Don, dated October 21, 1900, requesting the names of manufacturers of phonographs and gramophones. Mr. Rothstein wishes to deal direct with American firms. Not desiring to discriminate between dealers, the bureau takes this method of bringing the matter to the attention of those interested. The telegraphic address given is, Rothstein, Rostovdon.

THE PARIS EXPOSITION OF 1900.*

By CARL HERING.

A LARGE international exhibition, like the one about to close, may be judged from two standpoints. For commercial reasons a necessary feature is its general attractiveness, that is, its beauty, architecturally as well as in the arrangement of the grounds and in the decorations, its proper combination of instruction and entertainment, and its purely entertaining features. On the other hand, such an exhibition should be a representation of what is called the state of the art in the various industries, and, to a certain extent at least, show the relative importance of competing industries.

From the first of these standpoints this exhibition may be said to have been a great success. It certainly was very beautiful and attractive, and in this respect it was typically French, for to the Frenchman such an exhibition would be a failure if it were not beautiful. While there were undoubtedly a few architectural features that might be criticised unfavorably, yet, in general, the buildings and arrangements of the grounds left little to be desired, although the absence of straight lines in the architectural decorations of the main buildings might not meet with the approval of every American, for, in this respect, they differ typically from those in the Chicago Exhibition. The arrangements and decorations of the characteristically unsightly interiors of long exhibition buildings were also very tasteful and effective, although the avoidance of a regular system of aisles made a systematic study of the exhibition an almost hopeless task. In some of the attractions, such as the Optical Palace, the underground mines, etc., instruction and entertainment were combined, but as a rule the too numerous "side shows" were for amusement only, and were typically French.

From the other standpoint, that of showing the state of the arts, the exhibition may have been, and undoubtedly was, a success in many departments, but that claim can hardly be made for the electrical industry. For France, Germany, Switzerland, and a number of the other Continental countries, the electrical exhibits doubtless represented the true state of the art and the best general practice as far as these countries were concerned; but the absence of a proper representation from the United States proportionate to the enormous development, made the exhibition an incomplete representation of the present state of this important industry. Any one judging its development in the respective countries by their exhibits, would have obtained a very wrong impression of its progress in the United States, or of the general practice here. We sent over a few excellent electrical exhibits, and they were greatly admired, but there was general disappointment that a country in which the electrical industry is known to be so largely developed, was so inadequately represented. This is all the more unfortunate at the present time when our export trade of manufactured articles is growing so rapidly, and when our electrical practice, in certain directions at least, is thought so well of by foreigners that many of them come over here to study it.

The fact that several of our largest manufacturers have ceded their rights in foreign countries to local companies, and, therefore, claimed to have no interests there, may explain in part the absence of some of the important American electrical exhibits. But unfortunately these local companies do not always follow our practice, and do not manufacture the goods on the same scale and in the same way, so that their exhibits were not as a rule representative of our products.

England also was very inadequately represented in the electrical classes. The English claimed that they were tired of exhibitions, but another reason is no doubt the unfortunate political relation with France. England's exhibits in other groups also seemed to fail to represent the proper magnitude of the respective industries in that country.

Of all of those foreign to France, Germany, its

* Inaugural address by the president at the 147th meeting of the American Institute of Electrical Engineers, New York, October 24, 1900. From the Transactions of the Institute.

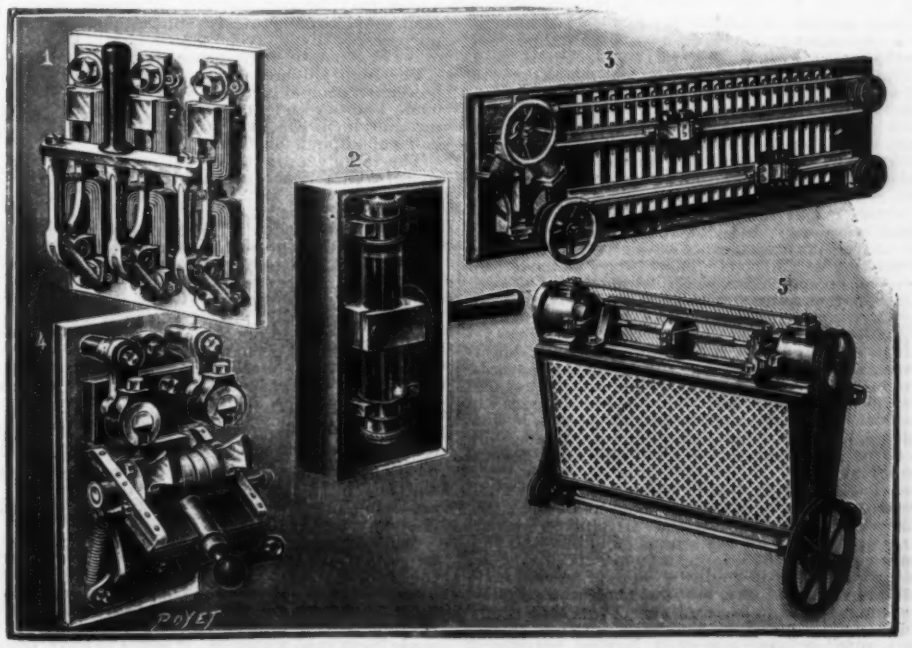


FIG. 2.—MODELS OF VARIOUS ELECTRIC APPARATUS.

1. A three-wire Vedovelli & Priestley interrupter. 2. A Genteur circuit breaker for high tension at 3,000 volts. 3. Double charge and discharge reducer of the Allgemeine Elektricitäte Gesellschaft. 4. Automatic interrupter of the Elektricitäts ..tien Gesellschaft. 5. Automatic regulator of the Société Lahmeyer, with contact voltmeter and signal lamps.

former bitter enemy, had by far the finest exhibits in most of the groups, including the electrical. Another feature of interest, politically, is that Hungary had in many respects better exhibits than its stepmother country, Austria, and was represented as an independent nation; it bids fair to become one of the greater industrial countries of the East.

The question is frequently asked how the Paris Exposition compared with the one in Chicago in 1893. As both were very large and creditable, a comparison becomes difficult, and in order to give an opinion of any value one ought to have studied both equally thoroughly, and under equally favorable conditions. It is also largely a matter of individual taste, and depends on the nationality of the one giving it, as also on the extent of his knowledge of French. The area of the Paris Exposition was 336 acres, which, together with the annex, made it about half as large in area as the Fair in Chicago, which had about 1,000 acres. The average number of paid admissions seems to have been about double in Paris, due to the fact that it was so managed financially that the average admission was about seven to ten cents, as compared with somewhat less than fifty cents at Chicago. Americans seem to have obtained their unfavorable views from antagonistic English papers.

It is thought safe to say that the Paris Exhibition, taken as a whole, was more generally beautiful in details, but that it contained no single group as magnificent as the famous Court of Honor, nor were the illumination effects as fine as at Chicago, where they were electrical, while in Paris gas was largely used, the whole of the largest open area, the Champ de Mars, being a brilliant mass of incandescent gas lamps. Neither had as finely illuminated fountains as the exhibition of 1889 in Paris, although the background to the poorly illuminated fountains in the present exhibition, forming the famous Chateau d'Eau, or Water Castle, was very beautiful and attractive.

The means of getting to and from the exhibition were very poor, as Paris has unquestionably the worst managed tramway and 'bus system of any large city in the world; its cab system, the best and cheapest of any large city, except, perhaps, London, was, of course, entirely inadequate and too expensive for the exhibition traffic. The exhibition, however, had the great advantage of being practically in the city itself, and in one which is admitted to be the most beautiful in the world, offering many attractions to visitors, and containing treasures which make it in itself an exhibition worth going to see. The Paris Exposition was decidedly more truly international than the one in Chicago, and the social intercourse of those officially connected with it was for this as well as for other reasons, including the generous hospitality of the French, more interesting.

The electrical exhibit was greater in Chicago, where it filled a large separate building, while in Paris it was confined to a moderately small part of one of the buildings.

Among the classes of exhibits of well-developed industries, there were three in particular which may be mentioned here specifically, as each marks a distinct and important direction of development, and was exhibited for the first time very prominently at a large international exhibition. They are the automobile, the incandescent gas lamp (known here as the Welsbach), and the three-phase generators, motors and systems. The automobile exhibit was very large, but unfortunately for the electrical industry, it seems that the gasoline vehicle is gaining very fast in the race with the electric. In Paris, where automobiles are used quite extensively, the quiet but heavy electric vehicle is seen only occasionally, while the light but noisy and malodorous one using gasoline is heard and smelt very frequently. The incandescent gas lamp was used in large numbers on the Champ de Mars, the only large open area in the exhibition, where arc lights would otherwise have been installed. Even the friends of the electric light must admit that the illumination produced by it was very effective, brilliant and white without being dazzling. This lamp is getting to be a very serious competitor to the electric light, and some of the European central stations, particularly in the home of its birth, Austria-Hungary, are having serious difficulty in competing with it. The third of these prominent classes of exhibits, the three-phase machinery, will be referred to below.

Another feature of indirect interest to the electricians is that most of the acetylene illumination was relegated by the authorities to two small strips of land unoccupied by any buildings, along the banks of the river, which seems to indicate that acetylene illumination is limited to a narrow field of its own.

Much else might be said about the exhibition in general, but we as electrical engineers are more interested in the electrical exhibits. As was already mentioned above, these were representative of the state of the art only as far as the Continental countries were concerned, as those from the United States and England were very deficient in scope. It was also stated above that it was less of an electrical exhibition than the one at Chicago. There were, moreover, no quite novel, epoch-making electrical inventions shown, although a few quite interesting ones, that were already known to readers of the electrical journals, were exhibited there for the first time. Detailed descriptions of all the important apparatus have doubtless been or will be given in the electrical journals, where they more properly belong, and where they can be read at one's leisure, and therefore no attempt will be made here to give such descriptions, even if time permitted, the intention being merely to mention some of the chief features, and to make some general observations.

One of the striking features was the great prominence of three-phase generators, and their size. One obtains the impression that the three-phase current has triumphed over all the others, including the continuous current, when large amounts of power are concerned, and that it would be poor practice now to install large units of any but the three-phase system unless one is forced to use another. There was shown a decided tendency toward the use of large units, and quite a number were exhibited having outputs of about 1,000 kilowatts and over. The greater number were for three-phase currents and all formed the flywheel of their direct-connected slow-speed engines, while all of the few large continuous current machines exhibited had to have a separate flywheel. That the field is made the revolving part seems to be almost universal practice, as also the distributed winding on the armature. Single and two-phase alternators and large continuous current machines were the exception.

Two very ingenious attempts were shown to compound large, three-phase generators, without commutating the main current, one by Hutin and Leblanc and the other by Boucherot. Both excite their direct current and mechanically coupled exciter by means of the three-phase alternating current, the exciter, therefore, having a revolving field but fixed brushes; in both, the excitation of the exciter is dependent on the voltage of the alternator and on the main current, in the former by means of a shunt and series field magnet coil, and in the latter by means of a transformer combining the effects of both. To obtain direct current from such an exciter the connections between the commutator and the coils in the former are reversed according to a certain law, while in the latter the armature has several windings differing in their number of turns according to a sine law. Both claim to keep the voltage of the generator constant for different currents and load factors. It will be noticed that there is no commutation except that of the small exciting current in the direct current exciter. Whether they are better or worse than the commutating systems used here, practice alone can decide. While they are interesting studies, it does not yet seem to be proved that for large units, at least, a cheaper attendant than these would require, with his hand on the rheostat and his eyes on the voltmeter, is not a more practical solution.

The amortisseur of Hutin and Leblanc, consisting of a short-circuited cage through the poles of the magnets, for facilitating parallel running, seems to be meeting with some favor and is being commented upon very favorably.

The largest generator exhibited was a 72-pole, 3,000 kilowatt three-phase machine, of the Allgemeine Elektricitaets Gesellschaft, of Berlin. Its speed was 88, frequency 100, voltage 6,000, weight about 160 tons, and diameter of revolving field about 24 feet. As many as twenty-one of these are under construction. It was claimed to be the largest in the world, but this is an error, as generators of 4,000 kilowatts and over are in use in this country at even slower speeds. Several others above 1,000 kilowatts were shown, the lowest speed being 72, of the 2,700 kilowatt mixed single and three-phase current Helios machine.

The direct generated voltages of the three-phase machines were from 2,000 to 6,000 volts; there was one exhibit of a comparatively small generator for 30,000 volts, but as long as good transformers can be bought, such excessively high voltage machines will probably be used only for exhibitions and laboratories.

There were a number of inductor alternators exhibited, which indicates that they are meeting with some favor.

Connecting lamp circuits to three-phase generators does not seem to be considered a sufficiently serious matter to overbalance the advantages of that system. The method used by the General Electric Company, of Berlin (that is, the Allgemeine Elektricitaets Gesellschaft, which even in Germany is generally abbreviated to A. E. G.) is simply to distribute the lights as evenly as possible over the three branches. All three mains are run into the buildings of even small consumers, although only two may be used, the third being available for changing over a batch of lamps, if necessary, for balancing. The voltage can thus be regulated only for all three branches together, and not for each separately; but this is not considered a serious disadvantage. The Oerlikon Company, on the other hand, connects lamp circuits between the ends of only two of the three branches of a star-connected winding, the third branch being then idle; this enables the voltage of that single-phase alternating current circuit to be regulated at the machine. By overloading these two circuits 15 per cent. the capacity of the generator is about the same as for motor circuits with a power factor of 0·8. The units in a station can then be alike, and it does not interfere with paralleling or running motors and lights from the same machine if necessary. Another method used in Switzerland, but only with two-phase generators, is to construct a sort of double machine, the two halves of which may be mechanically displaced relatively to each other to generate two-phase currents for power purposes, or they may be connected in line with each other to generate single-phase currents for lighting.

The high voltage, direct current series system for power transmission and very limited distribution made another and probably unsuccessful appeal for recognition in the form of an exhibit by its indefatigable champion, Mr. Thury.

The large engines exhibited were, as a rule, slow speed, which is the prevailing practice on the Continent. The very high speed steam turbines are also meeting with favor.

Among the various types of motors the most interesting was the three-phase induction or Tesla type, which seems now to have demonstrated its superiority over all the others except perhaps the continuous current motor, upon whose field it is, however, encroaching very decidedly, with the present prospect of becoming its equal in importance. The largest company in Germany, and perhaps in the world, estimates that its sale of three-phase induction motors will before long exceed that of its continuous current motors. Its very large factory, including even the rolling mill, is equipped with these induction motors, mostly direct connected. There is a single textile factory in Switzerland in which five hundred of these motors are used for direct driving. The induction motors, almost exclusively of the three-phase and not two phase type, are being introduced very largely now, especially in Germany and Switzerland.

A nearly uniform type seems to have been adopted by most of the makers. In this the primary circuit is the stationary one, and is distributed over the surface like a drum winding, as distinguished from the coils used in the earlier forms of Tesla. It is this distributed winding which is the chief improvement that has made them such a success; it seems to have been first introduced by Dobrowolsky in Berlin. The larger ones are almost always started with a resistance in the secondary external to the motor; in some cases a short-circuiting device is provided on the rotor for use after starting, so that the brushes may be raised while running, to prevent wear. It will be noticed that in some respects this nearly universal practice abroad differs from that in this country, where even very large motors, up to 800 horse power if not more, are made without any brushes, being started with a transformed current at lower voltage; others are made with the starting resistances on the rotor itself, which also dispenses with brushes.

Among the few other devices exhibited for starting such motors, the object of all of which is the avoidance of slide rings, may be mentioned the ingenious one of Fischer-Hinnen, who uses an inductive resistance of very low ohmic resistance, in parallel with a non-inductive one of high ohmic resistance; together they act like a high ohmic resistance when the motor starts, owing to the high frequency of the secondary currents, and diminish automatically as the motor increases in speed, because the frequency of the secondary then diminishes; they are permanently connected to the rotor. In the Deri motor the number of poles is changed by a switch in the primary, and the resistances are permanently connected between points of the secondary which have a difference of potential for one number of poles, but are of the same potential for a different number of poles; they are, therefore, either in or out of circuit and admit of no gradation, which is a disadvantage. Boucherot uses practically a double motor, the field of one of which may be mechanically turned through a certain angle for starting; the two secondaries are permanently short-circuited in series with each other, but have resistances connected between the coils through which the secondary current is forced to pass when one of the fields is displaced, but only then; it seems like a rather complicated device as compared with the simpler slide rings which it replaces.

For the A. E. G. induction motors, Dobrowolsky claims that they will stand a 200 per cent. overload, have a power factor of over 0·9 and still give the normal output of two-thirds the normal voltage.

Induction motors are built on the Continent for high voltages up to 6,000, and I believe even 10,000, thus saving the transformers for all but higher voltages than these.

As to single-phase induction or non-synchronous motors, it looked as though most of their makers thought it best not to exhibit them, or to evade questions asked about them. Among the exceptions may be mentioned the Brown and the Oerlikon motors, both of which start with an auxiliary winding. Brown, who constructs them up to 100 H. P., states that they start with ¼ to ⅓ full load torque at about normal full load current. He has even made them for starting with full load torque at about double normal current. The air gaps are very small, from 1 to 1½ mm. A cheap liquid condenser made of iron plates in soda solution is used for producing the artificial starting phase. The Oerlikon motors are claimed to start with ¼ normal torque requiring 80 per cent. normal current, and to stand an overload of 50 per cent. An impedance coil is used for starting.

A very interesting installation of single-phase motors, and quite a unique one, exists in Frankfort a. M., Germany, where about 500 such motors, mostly by Brown, are connected to the large single-phase alternating current plant, the motor load of which has leveled the load very decidedly. They vary in size up to 100 H. P. and are used even for elevator work. They appear to be satisfactory to the users, even though they must always be started unloaded. This is probably the largest motor plant of its kind and shows what can be done even with single-phase motors.

One of the applications of three-phase induction motors which is of special interest, and which seems to have a promising future, is to traction. This three-phase traction system, which is scarcely known in this country, is in regular and apparently very successful use on a number of lines in Switzerland, where it is being introduced by such well known constructors as Brown, Boveri & Company and the Oerlikon Company. A few of these roads were visited by the writer, and as far as could be learned they were running very satisfactorily. The double trolley wire, which is essential, and which has often been urged as being such a serious objection, does not seem to give any trouble at all; each locomotive or car had even two contacts with each wire. Many of the alleged objections are overcome by the use of the contact bar instead of the trolley wheel, which completely avoids any jumping off the pole, and greatly simplifies the overhead wiring at the switches, which is in fact not complicated at all. The motors are started with resistances in the secondary as usual. There is no complicated controller, as the two motors are always in parallel. The train starts well and without difficulty, and it seems without any very abnormal current. The chief objection to the system seems to be that the running speed is always the same, in which respect it is like a cable road; it is therefore not possible to make up lost time except on a down-hill coast, while on steep up grades there is a considerable demand for power, as the speed is always the same maximum. No system of efficient speed regulation is used, presumably because none has been found to be satisfactory. This seems to be the real and serious objection to the use of the system in this country, where high speed seems to be an essential requirement. One of the freight locomotives was provided with a purely mechanical device for halving normal speed, but no other information could be obtained than that it was then in the repair shop.

On that bold enterprise, the Jungfrau Bahn, which will ascend one of the highest snow peaks in Europe, a very ingenious and apparently novel device is used on one of the Oerlikon three-phase locomotives, in order to enable a train to descend to a habitable region, even if connection with the power house is broken or if something should happen to the trolley wires or poles. Ordinarily in descending, the induction motors act as generators, sending their current back into the line, which therefore must be intact. The device referred to consists of a small direct current generator driven by the descending locomotive, the current from which is led into one branch of the star or Y-connected primary and out at the other two ends in multiple; this excites the motor, and it then generates alternating currents in the secondary, which are dissipated in the resistances used for starting; it thus operates as

an electric brake without being in contact with the line.

While three-phase traction in its present state would probably not be practicable here for cities, there seems to be a field for it on long distance interurban lines with few stops, as it is much cheaper. The estimates for the Jungfrau Bahn showed that the first cost would have been 50 per cent. greater if the continuous current had been used on the locomotives, as is done in this country.

Returning to the subject of alternating current generators and motors in general, there is a characteristic difference between European practice and that in this country which seems worth mentioning. Here the coils are usually form-wound and then laid into open slots; there the wires are more generally threaded through completely closed holes as in the Oerlikon and Brown machines, or through holes of which the webs have been cut through with a very thin saw cut, as in the Dobrowolsky machines of the A. E. G. Mr. Brown gives the following reasons for his preference: lower magnetic resistance, smooth surface of core, seamless tube insulation, solid poles, ease in parallel running and avoidance of wedges, binding wire, etc.; his experience is that it takes as long to replace a form-wound coil as to thread in a new one in place. Dr. Behn-Eschenburg, the engineer of the Oerlikon company, gives his reasons as follows: The smoothness of the surface enables the air gap to be made as small as 0·001 of the diameter, in induction motors, which is hardly possible with teeth; with a web over the hole of only 0·1 mm. the coefficient of magnetic straying can be reduced to 0·04 and a maximum power factor as high as 0·92 can be obtained; the maximum torque will correspond with 3·5 times normal current, and the possible overload can be 2·5 times the normal; if the holes were changed into teeth, all else remaining the same, the magnetization current would be at least doubled, the straying coefficient reduced to about 0·08, and the best current for the resulting maximum power factor of 0·94 would then be more than doubled and the copper conductors therefore increased, or for the same load the power factor reduced to 0·91; the slotted armature would have to be made longer axially if it is to have the same current at no load as the one with holes; moreover, seamless insulation tubes of micanite can be used in the holes, which if 1 mm. thick will be safe for 3,000 volts. However, he quite impartially recognizes the favorable features of slots with form-wound coils and admits that they may outweigh the others if a factory is suitably equipped for such work; he believes that under certain circumstances the one, and under others the other, is the better.

Another interesting characteristic difference between American and Continental practice is that here synchronous converters combined with transformers are more generally used for transforming high voltage three-phase currents into low voltage direct currents, while on the Continent dynamos driven by high voltage induction or synchronous motors are the rule. Although the favorable features of each are well understood, the reasons given by such a successful constructor as Brown for preferring motor-generators may nevertheless be of interest here. He states that they can be regulated with ease and precision; no transformers; both parts can be better designed without making concessions; no hunting; ease in starting; no deplorization possible; secondary voltage absolutely independent of the primary. He admits that the synchronous converter is cheaper and more efficient, but claims that the differences are but slight; he has obtained 90 per cent. combined efficiency for a 250 K. W. motor-generator set.

The difficulty of not being able to regulate the voltage of a synchronous converter is overcome by Dobrowolsky in a very ingenious and apparently successful way. Instead of passing the continuous current through a booster, which would require an expensive machine, and generally with a very large commutator, he passes the alternating current though an alternating current booster on the same shaft; this is separately excited with a continuous current, and therefore permits of regulation. The one shown to me would raise or lower the voltage 25 per cent., making a range of adjustment of 50 per cent. It either drives or is driven by the converter. Although this overcomes one of the chief objections to synchronous converters, he has not changed his preference for motor generators.

Another modification of interest used by this same engineer and others is that six-phase instead of three-phase currents are led into the synchronous converter, the advantage being that its outpnt is thereby increased, according to a French constructor, about 45 per cent. The attending disadvantage of six slide rings instead of three is said to be more than balanced. The general use of three core transformers for three-phase currents instead of a single one for each phase, as is customary here, is another instance of a difference in practice.

It was of some interest to note the almost complete disappearance of the Gramme ring armature among generators and motors, and the use of multipolar fields for smaller sizes than formerly, especially with motors. The Dobrowolsky system, hardly known here, of supplying three-wire circuits from a single generator, by connecting the neutral through induction coils and slide rings to two opposite parts of the armature winding, seems to be meeting with favor on the Continent.

A criticism of American motors made by a prominent German manufacturer who has bought and tested many was that an American horse power was only three-quarters of a real horse power.

(To be continued.)

THE PARALLELOGRAM OF MOTIONS—A REPLY TO THE SO-CALLED EXCEPTIONS OF PROF. MACCORD.

To the Editor of the SCIENTIFIC AMERICAN:

In the SCIENTIFIC AMERICAN SUPPLEMENT for November 17, 1900, page 20803, appeared an article by Prof. C. W. MacCord that purports to show, by the use of models and otherwise, that the parallelogram of velocities does not always give correct results, or, to quote from the article: "If the two components are given, we shall presently see that notwithstanding the plausibility and elegant simplicity of the 'parallelogram of motions,' it is by no means to be taken for granted that its diagonal always truly represents the actual resultant motion, either in direction or in velocity."

The article sets forth clearly what is meant by the parallelogram of velocities in Figs. 2 and 3 and accompanying explanation; but in the application of the principle the author has deceived himself, and it is to correct any false impression upon others that the present article is written.

Let us first consider upon what the law of the parallelogram of velocities rests. There are many so-called mathematical proofs to be found, especially in the older books; but in all of these proofs some assumption is made which is as fundamental as the principle itself. Therefore, our faith in the truth of the laws rests upon experimental evidence. It is, therefore, of importance to show that Prof. MacCord's experimental models do not deny, but are in perfect accord with the law.

It is a rather curious fact that the present writer has for some years used models somewhat similar to those of Prof. MacCord, not for the purposes of disproving the law, but for class-room demonstrations of the law.

The article above mentioned bases the model and the exception to the law upon the following theorem: "If two points be so connected that the distance between them cannot change, the motions of these points are subject to the condition that their absolute components along the right line joining them must be of the same magnitude and lie in the same direction."

This theorem, though a trifle ambiguous in its wording, is correctly explained in the text relating to Fig. 4. The theorem is, of course, correct and rests for its proof on the parallelogram of velocities, or, in fact, might be made the definition of rigidity of a body. It is in the application that error comes and leads to so-called "exceptions."

Let us recall the author's model:

The model was thus described by the author: "In Fig. 5, two levers $A\,C$ and $B\,D$ turn upon pivots fixed at C and D in the base-board, $G\,G$; these levers are connected by the link $I\,K$, which for simplicity's sake is made equal and parallel to $C\,D$; and it has fixed in it

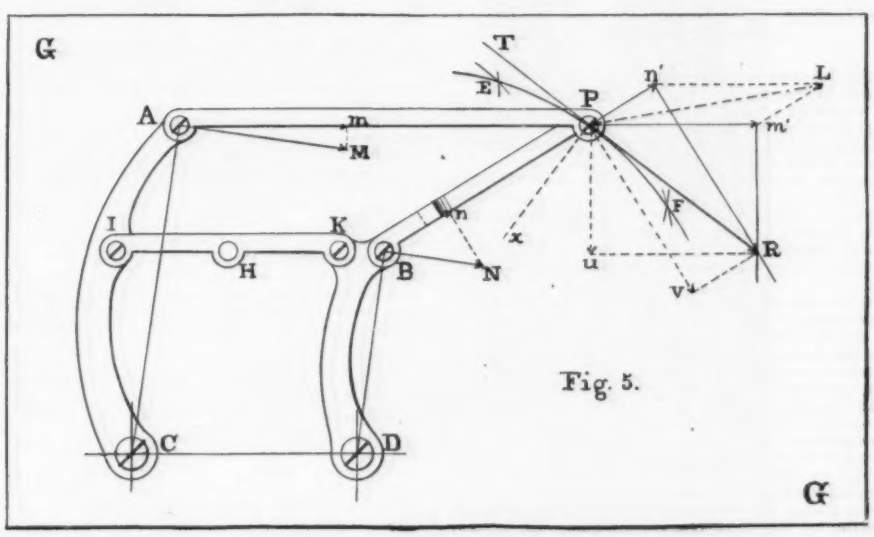


Fig. 5.

ILLUSTRATION OF A MODEL FOR DEMONSTRATING AN EXCEPTION TO THE PARALLELOGRAM OF MOTIONS.

a handle at H for moving the levers. Two links are pivoted together at P, and one is pivoted to the right hand lever at B, the other being pivoted at A to the left hand lever. Now suppose the handle H to be moved to the right, in such a manner as to give A a motion $A\,M$ perpendicular to $A\,C$; then B will have a motion $B\,N$ perpendicular to $B\,D$.

"The motion $A\,M$ has an absolute component $A\,m$ in the direction $A\,P$; m' the motion of P must, therefore, have a component $Pm' = Am$. In like manner $B\,N$ has an absolute component Bn along $B\,P$, to which $P\,n'$ must be equal.

"If, now, as one might be apt to do, we complete the parallelogram, the resultant motion of P would be the diagonal $P\,L$. But on moving the handle H to the right, the point in question perversely moves in the direction $P\,R$."

The author thinks, by the laws of the parallelogram, the point in question ought to move in the direction $P\,L$, whereas it does not. The fatal step in the author's reasoning is that the law of the parallelogram never said the point in question would move in the direction $P\,L$.

In concluding that the point P should move in the direction $P\,L$, the author has entirely left out of consideration two components of the velocity of P, as we shall presently see.

I. P, regarded as a part of $A\,P$, has a component of velocity $P\,m'$ in the direction of $A\,P$, and a component $P\,u$ (a fact that the author omits), perpendicular to $A\,P$.

II. P, regarded as a point of $B\,P$, has a component of velocity $P\,n'$ in the direction $B\,P$, and a component $P\,v$ (a fact that the author also omits), perpendicular to $B\,P$.

It is obvious that we can not pick out a part of the velocity of P regarded as a point of $A\,P$ and add it at random to a part of the velocity of P regarded as a part of $B\,P$ and expect to get correct results; yet this is what the author does.

I. 5 may be regarded as made up of two components, namely, 2 and 3.

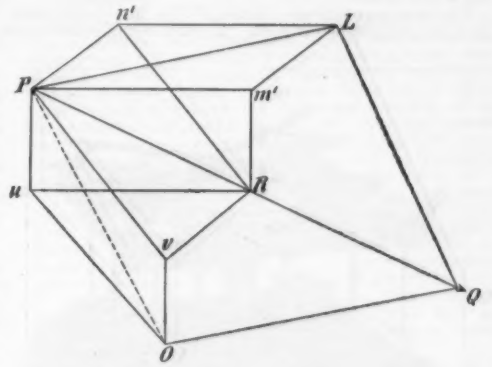
II. 5 may also be regarded as made up of two components, 1 and 4.

Now 2 + 1 do not happen to be five; nor do 3 and 4 happen to be five; yet the law of addition is as true as it ever was.

If one liked, one could add together 1 + 4 + 2 + 3 and get 10, and dividing the result by two, one would get 5. This would lead to no contradiction and would, of course, be legitimate. Let us do this in the case in hand. Let us then add together the parts that the author has cast aside, namely, the components of velocity perpendicular to $A\,P$ and $P\,B$, namely, $P\,v$ and $P\,u$; complete the parallelogram of which $P\,v$ and $P\,u$ are sides by drawing a line through v parallel and equal to $P\,u$, and a line through u parallel and equal to $P\,v$; draw the diagonal of the parallelogram thus constructed, and call the diagonal $P\,O$.

Now add $P\,O$ to $P\,L$ by the same parallelogram law of addition; and call the diagonal $P\,Q$.

$P\,Q$ will be the direction of the velocity of P, but will be double its magnitude. Therefore bisect $P\,Q$



and the result is $P\,R$. That is we have added $Pm' + Pu + Pn' + Pv$ by the law of the parallelogram as we add 1+4+2+3 by arithmetic and divided our result by two, and in both cases obtained correct results $P\,R$ and the number 5.

Thus it is evident that the author's error is one of omission; the normal components of velocity were as important as those considered by him.

The parallelogram of motion still stands without exception and hints that general direction of motion is along $P\,R$ and equal to $P\,R$.

I say "general direction;" for it is necessary to warn the reader that the velocities were resolved along and perpendicular to moving lines; for example $A\,P$ has both a motion of translation and of revolution. P has been considered relative to this moving line $A\,P$, whereas the path that P traces out on paper $G\,G$ is its absolute path in space. If the reader should construct a model for himself, he might be surprised to find that the point P turned rather shortly and went backward in general direction toward C, that is to say, there is a sudden change in direction of P motion in space when $C\,A\,P$ came into a straight line; this sudden change in direction of P's motion is due to the rotation of the line $A\,P$. The whole article applies then to slight displacements of P. Matters of relative velocity are for the mathematician only and too complicated for the general reader.

Since there is no exception to the law of the parallelogram of motion, as we have seen, of course the author's explanation of the exception, so called, falls without support. In the talk about the fact that P is not a free point, there certainly is a betrayal. The law of the parallelogram does not demand that P shall be a free point. The law states that if P moves, P moves in the diagonal of its component velocities, and always so moves and never otherwise. The great mathematician D'Alembert in his theorem of internal forces settled the question of such actions and reactions and this well-known theorem has never been called in question, either by experimenters or mathematicians. The theorem states that: "The internal actions and reactions of any system of rigid bodies in motion are in equilibrium among themselves;" and upon this his theorem of motion rests.

The reader will readily see that the so-called exceptions of Fig. 6 and following are to be met along the same lines as that of model of Fig. 5, which we have treated at length.

Men of science have come to have so much faith in the law of the parallelogram of velocities that a real exception to the law would be regarded as impossible as a perpetual motion machine. That is, the law of the parallelogram stands on the same footing as those of

conservation of energy or indestructibility of matter, that is, on experiment and observation, the great fountain source of knowledge.

GEORGE N. MCDANIELS, A.M.
Winsted, Conn.

THE CAMPYLOGRAPH.

THE accompanying Fig. 1, borrowed from La Nature, represents an apparatus which is called by its inventor (Father Dechevrens) a "campylograph" (from καμπυλος, a curve), and which is designed for drawing every geometrical figure imaginable, and simple and complicated algebraic curves.

The general principle of construction of the apparatus is as follows:

Two rectangular rods, *A* and *B* (Fig. 2) are each actuated by two coupled wheels. In each couple the radius

FIG. 1.—THE REV. MARC DECHEVRENS' CAMPYLOGRAPH.

and rotary velocity are the same, but may differ from one couple to the other. The pencil that traces the curves is carried at the intersection, *M*, of *A* and *B*. The registering paper is fixed upon the disk, *P*. If *P* is immovable, the resultant of the two oscillatory motions of *A B* is a Lissajous figure. Lissajous figures are obtained in lecture courses in physics through the reflection of a luminous ray upon two crossed tuning forks or by a combination of two pendulums swinging in two rectangular planes, one of which presents a horizontal plane upon which a stylus fixed to the other traces the resultant of the two oscillatory motions.

The advantage of the campylograph over these two classic processes is that it gives perfectly closed curves, which can be obtained neither with the tuning fork nor the pendulum, the amplitude of the swinging of which latter continues to diminish. The changes of velocity, moreover, can be made with extreme facility.

But the apparatus permits of obtaining many other things besides Lissajous figures. It is capable of tracing the resultant not only of two motions, but of three, four and five even. The composition of three motions is obtained by rotating the disk, *P*, while *A* and *B* preserve their oscillatory rectangular motions. The paper, in moving under the style that traces the resultant of the motion of the rods, transforms these elementary traces, and causes the appearance of new figures which have nothing in common with the preceding ones. The figures that we reproduce were obtained under such conditions. The curves of Fig. 4 are extremely complicated. Such complication, however, is not displeasing to the eye, but rather the contrary.

It will be seen that the campylograph, aside from its interest as a laboratory apparatus, is capable of furnishing incomparable motives of artistic decoration. The elegance and harmonious grace of its curves render it as attractive to the artist as interesting to the scientist. To the former will recommend itself the large model capable of industrial applications, and to the latter the smaller model designed for cabinets of physics.

UP THE IRTISH RIVER.

FROM Krasnoyarsk on the Yenisei to Omsk on the Irtish River is 738 miles, but nearly the whole of this distance is within and directly across the drainage basin of the Obi River. The Tchulim River, one of the principal eastern tributaries of the Obi, is crossed at Atchensk, only forty miles west of Krasnoyarsk. Indeed, in one place where the streams are still navigable, they are within six miles of each other. It is a singular fact of physical geography that all the long branches of the Yenisei are on the east side, while most of those of the Obi are on the western side. But really the proper continuation of the Obi is its middle branch the Irtish, which is in itself a river 1,800 miles in length, whose source is far up on the Mongolian plateau.

The garden of western Siberia lies in the valley of the Obi for a distance of three hundred miles south of the fifty-sixth degree of latitude. Here there are 100,000 square miles of well-watered, fertile prairie land, with a climate permitting the ripening of the most important cereals, and in every way as well adapted to cultivation as are the plains of Minnesota. Already there is in this belt a population of nearly 3,000,000. Much of the territory is also underlaid by coal-bearing deposits. Although these are mostly of Jurassic age, and carry a coal that is light—almost lignite—still it promises to supply the want of fuel fairly well, and is being mined extensively. Throughout most of Siberia, wood is still so plentiful that the locomotives ordinarily use it for fuel; but here they use domestic coal.

At all the important places in Siberia touched by the railroad, new cities are growing up about the stations. The old cities are built almost entirely of wood. Even most of the best houses are of logs. But the new cities are growing up like magic out of brick. In due time all will have to follow suit and build of brick, for the wood is rapidly disappearing. Logs are, however, the easiest material from which to construct a house suited to withstand the severe winters of Siberia. Brick houses here have to be of double walls with air spaces inclosed. But the making of brick is already serving a good purpose in diversifying the home industries. It is now one of the most prominent of the manufacturing interests.

The name of the station where the railroad crosses the Obi River is Ob, which until lately has not appeared on the maps. The old city on the river was called Krivostchekova, and was an important place of 10,000 inhabitants. Connected with this place by steamer up the river are the flourishing cities of Barnaul and Bisk, with populations respectively of 29,000 and 18,000; while a short distance below is Tomsk, with a population of 55,000 and a university of wide renown. One finds, therefore, that in coming to this part of Siberia, he is not out of the world. The mass of the people look and appear much as they do in any European city. The

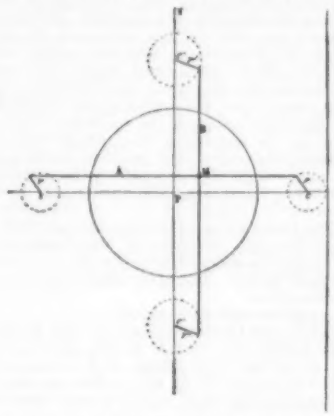


FIG. 2.—DIAGRAM OF THE APPARATUS.

teachers in the schools are highly educated men. More than once, when my Russian and French were insufficient for conversation, I have been asked if I could converse in Latin.

But Omsk, on the Irtish, is 333 miles west of Ob. Here we find a city, 184 years old of 42,000 inhabitants, which reminds us more of America than anything else we have seen. Not that the architecture is like ours, for it is not. The houses are nearly all of logs, and the schools and other public buildings of brick in plain style, painted white. The churches, too, are typically Russian, with lofty domes and cupolas. But there is a brisk commercial air about the place which reminds one of the towns on the Ohio River. Steamboats are coming and going, and the barges they have brought in are busy unloading their cargoes. Numerous rafts have also come down the river loaded with watermelons. In the stores the display of fruit is remarkable. But it is all imported.

Our plan led us here to leave the railway and go up the river about 600 miles to Semipalatinsk, and thence by tarantass 1,100 miles to Tashkend, where we shall find steam connection the rest of the way home. But we found, when already on the steamer, that the water in the Irtish was so low that they would ticket us only to Paviodar, about half way. We should then have to take our risk about finding boats the rest of the distance. But as we could get a tarantass there as well as anywhere, we did not change our plans. The ride for the first 300 miles up the Irtish is in most respects monotonous. The banks are low. There is not a mountain or hill in sight, and there are no forests. But there are other things of great interest. We are in a region inhabited by Kirghiz Tartars, and both they and their houses and habits are strange. Their houses are circular, dome-shaped tents, covered with skins of animals or felt. They raise thousands of cattle, sheep, and horses, which we frequently encounter as they are brought down to the river to drink. The men ride not only horses, but steers and camels as well. We had been surprised, in the market in Omsk, to see a camel hitched to a wagon and driven like a horse. We did not expect to see camels in latitude 55 degrees. Here, only two degrees further south, we saw many. In one case two were hitched to a familiar American mowing machine, and walking along with it through the grass at a rapid rate.

At Pavlodar we were compelled to abandon the boat, and go the remaining 200 miles by land. This brought us still nearer to the people, and did not delay us any, for the windings of the river are so many, and the Russians drive so fast, that we did not lose any time. We found ourselves, also, to be but one of several parties which were going nearly to our destination—i. e., several hundred miles—in tarantasses. One thing makes it easy to drive up the banks of the Irtish, namely, the fact that for several hundred miles the river has no tributaries. There were no streams to ford or gullies to cross. Saline lakes were drying up within a half mile of the bank. There are no trees except along the river bank. Cattle and horses are herded by the Tartars back from the river, and hay is gathered in common meadow land on the wide river bottoms. At this season of the year the trees were rapidly putting on their autumn colors; the first frosts were wilting the weeds; and hundreds of parties of quaint natives were stacking the hay, or hauling small loads of it near their houses. The entire distance was a scene of rare pastoral beauty and animation.

The Irtish valley has played an important part in history from the fact that it is one of the two or three natural gateways to Central Asia, rising by imperceptible gradients to the plains of Mongolia. Lake Zeizan, about half way up the plateau, is an enlargement of the river well nigh as large as Lake Erie. More than once the hordes of Central Asia, goaded on by the failing crops of that rapidly desiccating region, have poured down this valley and overwhelmed the settlements below.

Semipalatinsk was reached in two days and a half. This is a city of 35,000 inhabitants, at the head of navigation of the Irtish. But an immense amount of timber and of other coarse products is brought down from the upper portion of the river basin on rafts. Indeed, all the logs for the Russian houses are rafted down from far up the stream. The city is situated in a vast plain, with only a few mountains in the west in sight. About 150 miles to the southeast are the lofty peaks of the Altai Mountains, some of them rising 11,000 feet and supporting large glaciers. These mountains are also full of profitable gold-mines, and contain many fertile valleys watered by mountain streams.

The city was founded in 1718, when a fort was built here by the Russians as a defense against the lawless and disaffected Kirghiz Tartars. But these have long since become good and loyal subjects of the Czar, and mosques and churches now stand side by side, as if they were products of the same civilization. The territory tributary to this city has a population of several hundred thousand, and is so full of resources as to insure the permanence and, indeed, continued growth of the place. It has several large mills and manufacturing establishments, a museum and library, and numerous schools, both public and private. Of the private schools, nine are Mohammedan. The view of the city from a distance was enchanting. Some of the enchantment, but none of the interest, was dissipated upon close acquaintance. With its predominant popu-

FIG. 3.—CURVES OBTAINED WITH THE CAMPYLOGRAPH.

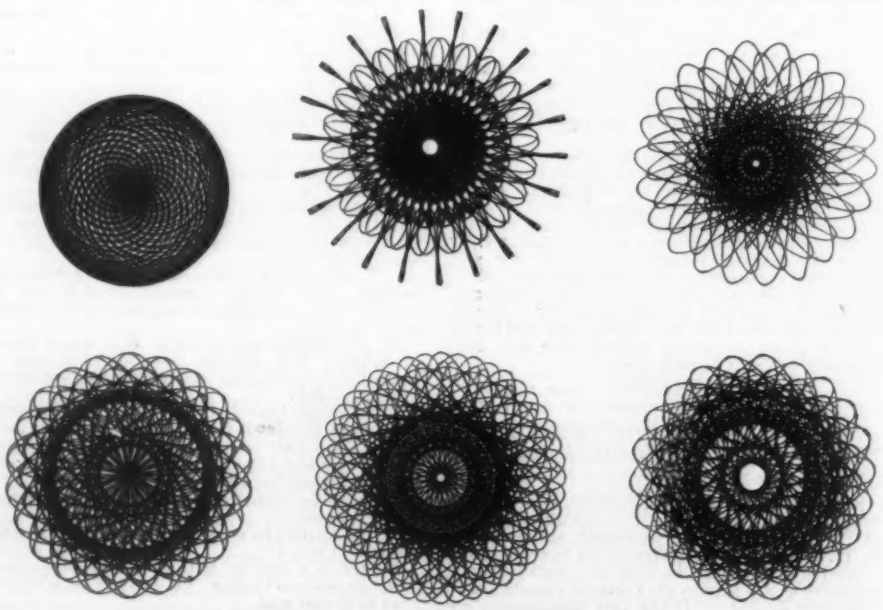


FIG. 4.—CURVES OBTAINED WITH THE CAMPYLOGRAPH.

lation of native but thoroughly Russified Mohammedans, it was an appetizing foretaste of the long ride we were to take through the Steppes of Tartary, in front of the border of the great plateau of Central Asia to the historic city Tashkend.—G. Frederick Wright, in The Nation.

LUMBERING THE BIG TREES.*

THE lumbering of the Big Tree is destructive to a most unusual degree. In the first place, the enormous size and weight of the trees necessarily entails very considerable breakage when one of them falls. Such a tree strikes the ground with a force of many hundreds or even thousands of tons, so that even slight inequalities are sufficient to smash the brittle trunk at its upper extremity into almost useless fragments. The loss from this cause is great, but it is only one of the sources of waste. The great diameter of the logs and, in spite of the lightness of the wood, their enormous weight make it impossible to handle many of them without breaking them up. For this purpose gunpowder is the most available means. The fragments of logs blown apart in this way are not only often of wasteful shapes, but unless very nice judgment is exercised in preparing the blast, a great deal of the wood itself is scattered in useless splinters.

At the mill, where waste is the rule in the manufacture of lumber in the United States, the Big Tree makes no exception. This waste, added as it is to the other sources of loss already mentioned, makes a total probably often considerably in excess of half the total volume of the standing tree; and this is only one side of the matter.

The Big Tree stands as a rule in a mixed forest composed of many species. The destruction caused by the fall of the enormous trees is in itself great, but the principal source of damage is the immense amount of débris left on the ground—the certain source of future fires. This mass of broken branches, trunks, and bark is often five or six or even more feet in thickness, and necessarily gives rise to fires of great destructive power, even though the Big Tree wood is not specially inflammable. The devastation which follows such lumbering is as complete and deplorable as the untouched forest is unparalleled, beautiful, and worthy of preservation. As a rule it has not even had the advantage of being profitable. Very much of this appalling destruction has been done without leaving the owners of the Big Trees as well off as they were before it began.

LUMBERING BIG TREES ON KINGS RIVER—MAKING GRAPEVINE STAKES; SHOWS THE EFFECT OF BLASTING WITH POWDER.

ON THE PRESERVATION OF NATURAL OBJECTS IN ALCOHOLIC AND OTHER SOLUTIONS.

By NICOLAS PIKE.

COLLECTIONS of specimens of natural history are of comparatively little use to either student or scientist unless the greatest care is observed in their preparation and preservation. The naturalist Swainton said that "collections of natural objects in public and private museums are to the naturalist what a library is to the critic and scholar, yet with this remarkable difference, that one draws his knowledge from the works of man, and the other from those of God."

Now I go still further—museums are of the greatest utility not only to the naturalist, but when well managed to the people at large. Besides being places of resort for recreation and amusement, they are also an education in themselves to toiling men and women who have no time for study at home. Thousands of objects are brought together from all parts of the world, and when carefully prepared are invaluable in imparting a fund of knowledge no books could give. Every one knows the difference between seeing an object and reading of it, even when fairly described.

In some of the museums I have visited in the old world and in others of our own country I have noticed that many of the rarest and finest specimens were ruined from having been badly prepared in the first instance, and others from a lack of knowledge as to their keeping. This is especially true of objects preserved in alcoholic and other solutions.

When in Mauritius, I made a very large collection of the fish of the Indian Ocean and sent them to the museum of comparative zoology at Cambridge, Mass. When they reached their destination, though many of them had been in alcohol for over a year, they somewhat surprised the distinguished scientists there, for all were fine, and many had retained some of their colors and markings so well they were easily recognized. I have reptiles, batrachians, spiders, etc., now, that have been for years in bottles, and they are firm and fresh. So many friends and naturalists have asked and written to me about my methods of preservation that I give the following formulas, which I have proved to be the best I am acquainted with. They are simple and do not differ much from the ordinary ways naturalists have preserved for years—yet the slight differences mean success or failure.

Taking fish, for instance, I proceed as follows: When first drawn from the water, I kill it by severing the vertebra near the tail, as I have proved beyond a doubt that a fish dispatched as soon as caught keeps better than one left to die a natural death. All but very small fish should have an incision made near the vent to allow the gases to escape, and alcohol be injected through the vent and mouth. All extraneous matter is to be carefully washed from the fish with fresh water and then it must be placed in strong alcohol, the stronger the better. Four to six days are generally enough to render the flesh firm and all slimy matter exuded, but practice and judgment on this point are required. When ready, wipe the fish and place it in the following solution, and it will keep for years if good alcohol be used:

Alcohol (95 per cent.)	8 parts.
Distilled water	3 "

If the fish are small, three or four days suffice to harden them, and the following is a better solution for them, viz.:

Alcohol	6 parts.
Distilled water	2 "

Reptiles, rodentia, etc., can be also preserved in the same manner. The first alcoholic bath can be used over and over again for the same purpose if strained and well corked, as alcohol is an expensive item in collections.

It is but too prevalent a custom to keep specimens of natural history in the strongest alcohol and place them on the shelves of a museum or cabinet exposed to a bright light. This is ruin to them, as every one knows it is impossible to expose any matter to the sun's rays without its being influenced by their action.

For the preservation of tadpoles, young frogs, salamanders, and similar objects, take 1 pound sulphate of zinc, 2 drachms burnt alum, and mix well together.

When wanted for use, take one drachm by weight of the above and put it into forty-two ounces of pure spring water, and when all is dissolved, filter and let it stand five or six days, then filter again and decant, when it should be a bright and sparkling fluid. The above small animals are to be placed for a short time in alcohol to harden. When taken out they must be well washed in clean water and left to dry a little, so that all traces of the alcohol may be evaporated. When placed in the above solution, they must be corked immediately. Specimens thus prepared are really beautiful, more so than when put in any alcoholic mixture.

The following solution for larvæ of insects, spiders, and other small delicate objects will be found very valuable:

Glycerine	1 oz.
Common salt	1 dr.
Saltpeter	1 dr.
Distilled water	8 oz.

Mix well together.

When wanted for use, take two ounces of pure alcohol and add one ounce of the mixture, shake well, and filter.

There is another solution I use for delicate objects I intend for dissection or anatomical specimens, as it keeps them fresh and flaccid without the least contraction. I have adopted the formula given below as the very best preservative for the above purposes, after years of patient experimenting. I have larvæ of insects, worms, spiders with soft bodies, etc., over ten years in this solution, and they are in excellent condition, and have never shown the least sign of decomposition. Take of chloral in crystals one ounce and dissolve it in five ounces of distilled water:

Alcohol (95 per cent.)	1½ oz.
Glycerine	1½ dr.
Rock salt	15 grs.
Saltpeter	30 grs.

Dissolve the glycerine, salt, and saltpeter in the alcohol, and when well mixed add to the chloral solution, shake well till thoroughly incorporated, filter, and it is ready for use. Specimens intended to be preserved in this solution should be placed for a day or two in alcohol, but if wanted for dissection quickly, or only to be kept a few weeks, the alcohol bath may be omitted. Do not crowd the specimens either with this or any other of the solutions, but see well to the corking and that they are quite covered with the fluid.

The tadpoles of frogs and salamanders can be preserved in this method by omitting the bath and placing them at once in the solution. This is invaluable for medical students, entomologists, and scientists, as it not only preserves objects, but in many instances the colors are retained if kept in a cool, dark place.

I tried the Wickersheimer process, but it failed in my hands completely. Goadby's solution I find after a time makes a white deposit on the specimens, thereby spoiling them.

I keep my reptiles in a cool place with a paper cap over each bottle, and can recommend this plan. The smaller objects are shut in closed cabinets. Where the paper cap cannot be used, I would suggest that a curtain be drawn in front of shelves containing alcoholic specimens when not required for exhibition. By following the above directions, success is pretty certain, though, as I said before, judgment and practice are requisite to insure it—simple as it appears.

I would say a word to those who collect with the intention of presenting their catch to some institution. Never forget that it is the first manipulation of the various objects that requires attention, as no after care can wholly undo the effects of negligence or ignorance in that stage. Especially be particular to place your name, date, and locality on your labels.

PARAGUAYAN FRUITS.

GUAVA is one of the most abundant of Paraguayan fruits. There are immense numbers of trees throughout the country, and women bring the fruit in bushel baskets to Asuncion. It is a yellow-skinned fruit about as large round as a five shilling piece and contains many small seeds. The tree looks like a plum tree and yields about one bushel and a half. The guava season is from January to April and commences again in August. This fruit, says the United States consul at Asuncion, makes a delicious jelly, clear and light red in color. The fruit is also used to make paste. Naranjitas, or small bitter oranges, produce excellent preserves. They are about the size of a lemon. The bitter taste is removed by immersion in running water, and the orange entire—skin and pulp—is preserved. This orange is said to hold the flavor much better than the sweet variety. Three years after planting the tree is ready to bear, and it sometimes bears twice a year. The lemon, or limon as it is called in Paraguay, is not found in as great abundance as the naranjita, but is also of extensive growth. It is not quite as large as our lemon and is preserved entire like the naranjita. The lemon tree produces from two to three bushels. Aguai is a most delicious fruit, the size of a plum, with two or three shiny seeds. The tree is the size of a large apple tree and yields about four bushels. Many are found in the vicinity of Asuncion, especially in the town of Lam-

* From "A Short Account of the Big Trees of California," by Gifford Pinchot, Forester United States Department of Agriculture. Bulletin No. 28, Division of Forestry.

bare, also in Campo Grande. Abacaxis is a kind of Brazilian pineapple that has been introduced into Paraguay and grows abundantly. It is very juicy and exceedingly sweet. It is stated by experienced persons in Paraguay that the abacaxis when preserved will retain its flavor and remain fresh for years.

CAN THE AMERICAN SHIPBUILDER UNDER PRESENT CONDITIONS COMPETE WITH THE BRITISH AND GERMAN SHIPBUILDERS IN THE PRODUCTION OF THE LARGEST CLASS OF OCEAN PASSENGER AND FREIGHT STEAMSHIPS?*

By GEORGE W. DICKIE, Esq.

I AM presenting this paper to the society in response to a request received from the secretary before starting out on a trip to Great Britain and Europe, the object of which was partly to note what advantages the shipbuilders there had over ourselves, either in skill, labor, or material, that would enable them to produce these great ocean freight and passenger carriers at less cost, or with greater certainty as to results, than ourselves.

This paper is being written on board one of the latest examples of the shipbuilder's art in that combination of great cargo capacity and a moderate amount of very comfortable passenger accommodation, combined with a speed that was considered fast not so many years ago. The steamship "Saxonia," on which I am writing this paper, is the embodiment, I think, of a higher type of skill in naval architecture than those vessels wherein everything is made subordinate to the one-sought-for quality of speed.

This type of ship will, I believe, become the most important in the future extension of American shipping. Here is a vessel that carries 9,000 tons of freight at 15½ knots on a coal consumption of 145 tons per day, or 1,200 tons of fuel used to carry 9,000 tons of cargo across the Atlantic, and at a speed that secures a large passenger patronage. Now, the secret of obtaining this result is, first, the great increase in the size of the ship, and second, fitting engines of just the size required for the speed. The old idea of having a large surplus of engine and boiler power that the owner can never afford to run at its full capacity is a thing of the past, and ships are now designed with just sufficient power to meet the conditions as required by the trade in which they are to engage. Increased efficiency of engines and boilers has also helped in this astonishing result.

The question that forms the subject of this paper is one that has ever been present to my mind while visiting British yards and talking with British shipbuilders, and in trying to find an answer I have endeavored to compare ourselves with them in the three factors that enter into production: Skill in design, cost of labor, and cost of material.

In regard to skill, I have always found it difficult to make any just comparison between the product of one shipbuilder and another, the term meaning different things to different people. Skill in design must in merchant work have the commercial element as a prominent factor, and must embrace both the financial interests of the shipbuilder and the shipowner; and in order to prevent these interests from injuriously affecting the interests of the shipper who intrusts his property on the vessel, and the interests of the underwriter who insures the interests of the shipowner and merchant, certain societies representing all the interests involved hedge the designer about with rules that give him but a very narrow field in which to exercise his skill as a naval architect. Yet, narrow as this field is, the progressive shipbuilders of Europe are continually pushing out the barriers, and forcing the recognition by the registration societies of new methods in construction, new properties that experience has shown to be desirable, and new combinations that have transformed, within the past few years, not only the dimensions of the ships built, but the whole method of construction. So that, hampered on every side as the naval architect is by rules and traditions, his skill has been ever on the alert for the smallest opportunity to push out still farther the barriers set up against him.

In thus stating the obstacles that oppose the exercise of the naval architect's skill in design, I do not set these obstacles down as opposed to progress, but as limitations to the free exercise of the skill in design that many naval architects, and especially those of America, think they possess. When the ambitious young naval architect studies the rules, say of Lloyd's Register of British and Foreign Shipping, his first impression is that those people who make and maintain these rules are opposed to all progress, and imagine that they and the rules they have made represent the consummation of all that is possible in shipbuilding. As he gains experience, however, in his work, this first impression of his will be modified.

I have lately had to discuss with the chief surveyors at Lloyd's certain departures, that we considered slight and in the line of improvement, from the rules as applied to two large freight twin-screw steamers we are now building. I have found that the skill of the experts at Lloyd's, and the careful study of every proposition made to them, not only protects all parties, but insures a steady forward movement, consistent with the proper protection of all the interests involved.

I believe, however, that an American register of shipping, that would be accepted by the shipowner and by underwriters the world over, would be a great help to the American shipbuilder, as it would no doubt lend itself more readily to the tendencies of American design. The British ship is the result of British experience, gained by British shipowners and sailors, embodied in British designs by the British naval architect, finally taking form in British shipyards; the result carrying with it much of the traditions and practice of the people and place where the work is done.

Now can we in America do better than this? We are very likely to do a little different, as much different probably as the limitations referred to will allow, and these differences will, I think, take the form of a closer adaptation of the material used to its place and function in the complete design.

In this the steel manufacturer will likely take a share. As he becomes better acquainted with the special needs of ship construction, we will find him ready to undertake new sections better adapted to take the strains and stresses of ship structure, and reducing built-up work to a minimum. We are on this point now abreast of the British builder, and, in methods of handling, ahead of most of them. In skill I think the American naval architect is quite abreast of his British cousin, and if he has plenty of practice, there need be no fear of his keeping there.

In some of the great shipyards of Britain and Europe they have acquired a greater experience in the production of the largest ocean steamships, both for passengers and freight, than we have; but we are in the way of obtaining this experience, and it will come to us just as it came to them, by a steady and skillful application of what we now have.

I find, also, especially among the younger naval architects in Britain, an opinion they are ready enough to express, that the United States is to be in the near future a rich field for the practice of their profession. I have found this opinion naturally strongest among those who feel the limiting power of British shipbuilding traditions strongest. Such men, if they come to our side, will have an effect in moulding what may become American traditions in the future of the art.

Granting, therefore, that there is nothing lacking in skill on the part of our designers, how are we in regard to the second factor in the problem of competition—that of the cost of labor? This is the one factor that presents the greatest difficulty in dealing with the problem of relative cost as between the shipyards of Great Britain and those of America. We work under different conditions in regard to a large portion of the work. The whole steel work of a ship may be said to be done under the piece-work system in Britain, the price per unit being fixed for certain shipbuilding districts between the shipbuilders and the unions representing the men. This method has its advantages, as it simplifies the estimating—a certain known portion of the work having a certain fixed value.

While a considerable portion of the work with us is done on some piece-work system, every yard appears to have its own way of fixing prices with the men.

In the British yards, as with us, while practically all the steel work is done under some kind of piece system, yet on inquiry it appears that it is with them very much as it is with us; the number of men on wages on the very work supposed to be done by piece is greater than that of the piece-workers, and skill in management is directed to the reduction of the number of men on wages as compared to the number on piece work.

From combining what information I have been able to gather, I find that on an average the steel work of construction costs in the British yards from £3 17s. to £4 per ton of material worked. This I think we can about equal in labor cost here. But when it comes to fitting out, including carpenter and joiner work, painting, and general finish, where piece work does not cut any figure, the cost, I think, is directly as the wages paid. We employ the same class of men as they do; in fact, our best men come from the British yards, and while in some of our yards we may have some advantages in climate, this does not apply to all, and where we are paying 50 per cent. more wages, the cost of labor that is reckoned in wages will be 50 per cent. more here than it is in the British yard. And if half the labor cost for any given ship built in a British yard is paid in wages—and this is very nearly correct—and that half costs 50 per cent. less than the corresponding part in our yards, our total labor cost will be 25 per cent. greater than theirs. This is very nearly correct, as tested by comparisons I have been able to make of actual costs as between our yards and one or two in Britain, where I have been furnished with labor costs. I am convinced, however, that although we pay higher wages to our office staff of draughtsmen, that part of the work does not cost any more than in the British yards, as we seem to be able to do a like quantity of work with a smaller force.

The managing staff in our yards are, I think, paid less than corresponding officers in the large yards there, and they devote much more time to their duties.

As to what we may be able to do in regard to equalizing the cost of labor as between our yards and those of Great Britain, I do not think that it will be brought about by any attempt to equalize the rate of wages paid throughout the shipbuilding world, but I have hopes that some of our rising shipbuilders among the younger members of our profession may be able to devise some method whereby every part of a ship, both hull and machinery, will have a labor value fixed for it that will not exceed what such a piece of labor costs elsewhere, and that whoever, by his labor, contributes to the production of that piece shall receive as recompense his portion, that is, the percentage that his labor represents in the total labor required to complete the part on which he worked.

Something of this kind must be the foundation on which any true settlement of labor values must rest, and as it is done now with eminently satisfactory results in some of the most prosperous machine manufacturing establishments in England, it only needs the right kind of skill, honestly applied, to make it work in shipbuilding and engineering establishments in this country. I am so impressed with this, to me the only just way of recompensing labor, that were I twenty years younger I should take it up as a life work.

I find that the marine engine and its boilers cost less in proportion to the hulls than they do with us. This is no doubt due to the fact that neither there nor here does piece work prevail in the production of the marine engine or its boilers, while machinists and boilermakers receive at least 50 per cent. more wages with us.

In small tools I think we are better equipped than the engine works attached to the large shipyards there, but in heavy tools we are not better off than they are.

Some prominent engine builders in this country seem to be able to compete with engine builders in Great Britain, sending their engines to the very centers of engine building in that country, and, so far as we know, with profit to themselves. At least they continue doing it, which would indicate that it is profitable. If this can be done with land engines it can also be done with marine engines, but not on present methods. We must be content without the professional luxury of introducing some engineering novelty with every ship we engine.

I do not say that we should be satisfied without making substantial progress in marine engineering, but healthy progress is not inconsistent with a standard system of working that would greatly reduce the labor cost of producing a modern marine engine.

In a large and prosperous engine works that I visited in England, building a special type of engine, but in all sizes from 10 to 3,000 horse power, I found that the term erection was not used. Every part of their engines is made to gage, and when finished from the tools is sent to an expert examiner at a large surface table, with accurate measuring instruments, whose business it is to determine if every operation performed by the tools on that piece has been accurately done; that every hole has been bored properly; that every face is in its proper plane. He signs the workman's card that did the work if it has been done correctly; if not, the work is returned to him for correction, or rejected if it cannot be corrected. Every piece of work has a fixed labor value. Every man gets his regular wages. If the work he produces exceeds in labor value the wages, he is credited with 50 per cent. of the difference. If the labor value of his work is continually less than the wages paid him, he cannot continue to work in that establishment. The pieces thus produced that go to make an engine when brought together are not erected as we do, fitting each piece to its place by file or chisel, as may be, owing to defective tooling; but they are placed in stock ready to be assembled in a few hours on receipt of an order for an engine of the size they represent. A system to insure correct tooling on every piece entering into the construction of our marine engines would, in my opinion, reduce the cost of erection by one-half. Some such system, and making every man a partner, so far as the result of his own labor is concerned, would place us in marine engineering where we are now in the production of land engines.

If we are to pursue the same methods as we are now doing, which are just the same as those that prevail in the shipbuilding and marine engineering centers of Great Britain and Europe, our labor costs will be very nearly in proportion to the rates of wages as compared with theirs. But in the development of some plan whereby we can fix a labor value for all our work that will not exceed theirs lies our salvation, and the American workman would, in my opinion, profit largely by the general adoption of some such plan.

On our present methods our labor cost is, as near as I can compute it, 25 per cent. greater on the hull and 50 per cent. greater on the machinery of an average ocean-going freight and passenger steamer. I trust this statement will be carefully discussed by any member of this society who has any knowledge on this question of labor costs, for much of our future progress in shipbuilding depends upon how we are able to solve it.

In regard to the cost of material: I am afraid that this part of my subject is beyond my ability to in any satisfactory way compare our conditions with those of the British or European shipbuilder. The most important material affecting the cost of shipbuilding is steel, and the tremendous fluctuations that at times take place in the price of that material in this country is the most serious question we have to contend with in trying to predict anything in regard to the future of shipbuilding in this country. The tariff on steel plates and shapes makes it possible for us to find the British shipbuilder working into his ships American steel from Pittsburg at a less cost to him than the English material, and at less cost than is charged the American shipbuilder for the same material in Pittsburg. I saw in a yard on the east coast of Scotland steel being worked into a vessel that was delivered in the yard from Pittsburg at less than £7 2s. 6d. per long ton. If the American steel manufacturer can meet the British steel manufacturer on equal terms in the British shipyards, somehow it seems as if it might be possible for the American shipbuilder to get his steel material as cheap as the British shipbuilder gets his. This is all that I possibly can advance on this part of my subject. As the duty on steel of this character is not a protective measure, and cannot possibly produce revenue, it should not be maintained to render wild fluctuations in price possible.

I may be wrong, however, as to the cause of the immense variations in the price of steel here, but I think I am right in saying that such conditions relative to the most important material he uses are a great obstacle to the progress of the shipbuilder in this country. Engine and other forgings cost more with us than they do in Britain and Europe. In ordinary forgings of steel this difference is from 30 to 50 per cent., and in high grade forgings, such as required by our Navy Department specifications, there is no comparison. The usual extra charge for nickel steel forgings in Britain is £4 per ton extra for each 1 per cent. of nickel in the steel. I did not find nickel steel forgings being used at all in merchant work.

On the whole, I think the British builder has an advantage over the American builder in the cost of material. This applies even to the wood used. As near as I can judge at the present time there is 10 per cent. in cost of material in favor of the British shipbuilder as compared with the cost of material in American yards.

From the foregoing, if the statements I have made are correct, we are not yet in a position to compete with the shipbuilders of Britain or Europe, Europe meaning Germany only I think, in this connection, the difference being not less than 15 per cent. on the finished ship.

As we gain experience and adopt new methods, especially in regard to the management of that most important factor, labor, this difference may ultimately disappear. Some wise legislation will have to be devised that will enable the American shipowner to build his ships here, although costing somewhat more, until we have found out the way to pay American labor to build American ships that will not cost more than the British ship built by British labor.

I am conscious of the fact that, although I have tried to place this subject fairly before the Society, I have failed to present it in any new light. Somehow it belongs to that class of subjects that cannot be demonstrated by any statement of facts, as facts in one place are not facts in another, and facts to-day are not facts to-morrow.

I am afraid that we must hope for more than we can

*Paper read before annual meeting of Society of Naval Architects and Marine Engineers.

at present see. Perhaps the subject touches too closely the business interests of those of our members best qualified to discuss it, and on that account we may not get as free a discussion of it as would otherwise be the case. Yet its importance should command the interest of our members and lead them to place before the Society their thoughts on the questions I have tried to answer in a negative sort of way.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Labor Legislation in New Zealand.—In compliance with instruction, says Consul Frank Dillingham, of Auckland, I beg to say that the labor laws of this colony were enacted in the effort to regulate certain conditions affecting employer and employed. Their scope embraces many difficult positions into which the exigencies of modern industrial life have forced those engaged in the trades and handicrafts. The general tendency of the "compulsory conciliation" law, say its supporters, is to ameliorate the position of the worker by preventing social oppression through undue influences and unsatisfactory conditions of sanitation. It will doubtless be found that, with the advance of time, these laws are capable of great improvement and amendment; but they have already, their friends assert, done much to make the lives of operatives of fuller and more healthy growth. Their aim is to check abuses before these attain formidable dimensions; but that these laws have not prevented abuses is pretty generally admitted, and, inasmuch as the "rosy" side of the question has heretofore been given in reports published in the United States, I deem it advisable to give the other side as well in this report.

The most important of these labor laws in its general significance is that dealing with compulsory arbitration in labor disputes. The "industrial conciliation and arbitration act" of 1894, with its amending act of 1895, is supposed to have been enacted for the purpose of encouraging industrial association, and to facilitate the settlement of trade difficulties, but it is very doubtful if it has succeeded in doing this.

Under this act, any society may bring a disputed case before the board of conciliation appointed for that district, and, if the board fails to effect a settlement, the dispute may be referred to the court of arbitration, whose award may be enforced in the same manner as an award of the supreme court. The amount, however, for which such an award may be enforced against an association is limited to $2,500 (£500).

Combinations or associations of persons for regulating the relations between masters and masters, or masters and workmen, or workmen and workmen, are directed by the "trade union act of 1878."

The manufacturing population in this colony differs somewhat from that in some of the Australasian colonies by its wide dispersion. Wellington, the capital, has heretofore been unable to draw to itself the industrial activity of the other provincial centers; Auckland, Christ Church and Dunedin vie with it, not only in population, but in commerce. It is claimed by the friends of the compulsory conciliation act that the general dispersion of industry in the colony requires both a system of supervision and legislative measures of a peculiar character, sufficiently elastic to comprehend many varieties of function, yet rigid enough to crush any apparent abuse.

For some time past the employers' association and the industrial association in the south of New Zealand have united and tried to get the Auckland Employers' Association to join them in an effort to resort to the court of appeal, and, finally, to the privy council, to test the validity of the "tyrannous"—as they call it—preference of trade-unionists to non-unionists in the labor market. An important decision was given at Wellington on May 10 last by the court of appeals, regarding the award of the arbitration court in labor disputes under the industrial conciliation and arbitration act. It has been the custom for the arbitration court to place a clause in the award compelling employers to give trade-unionists preference for employment in a particular industry. Recently, the master plumbers and gas fitters at Christ Church applied to the supreme court for a mandamus to prevent the arbitration court from giving preference for employment to members of the trades union, in the dispute then under review. Judge Denniston held that the court had a perfect right to give such an award, if it thought fit, and dismissed the motion. This decision was appealed against, with the result that the full court has unanimously decided in favor of the judgment. The following selections from the opinions expressed by the several judges are instructive as illustrating official opinion in the interpretation of the law:

In the course of his judgment, the chief justice (Sir Robert Stout) stated that non-unionists were altogether outside the act. They had been excluded. A non-associated workman had no status under the statute. The statute must be obeyed, however contrary it might be to what was deemed natural justice. The status of individuals might be changed and the rights of persons affected, and there was no appeal to any other court in New Zealand. Then, the disputes must be in reference to "industrial matters," which were duly defined in the statutes. The definition of "industrial matters" seemed to his honor to include every kind of possible dispute that could arise between an employer and his workman. The act, in effect, abolished "contract" and restored "status." The only way the act could be rendered inoperative was by workmen not associating or not joining any union, for, as had been said, the statute could not deal with unassociated workmen. No doubt, the statute, by abolishing "contract" and restoring "status," might be a reversal to a state of things that existed before our industrial era, as Maine and other jurists had pointed out. The power of the legislature was sufficient to revert to this prior state. The only question the appeal court had to determine was, whether the words of the act were clear enough to show that the court of arbitration had the power claimed for it. In subclause 6, power was given to the court to deal with the status of workmen. He was of opinion that, having this power, the court had power to declare that trade unionists should have preference over workmen not belonging to a trade union. In the case of an associated workman, the arbitration court could give the preference, if it chose.

That is to say, so long as some persons will form trade unions, the act will be operative, unless repealed by government, which is not likely as long as trade-unionists can make and unmake parliaments.

Mr. Justice Williams said:

"If the arbitration court had jurisdiction to consider a dispute, it also had jurisdiction to decide it in such a manner as it considered just. The act conferred no status on a workman who was not a member of a union. It was not intended that they should be represented, nor did it contemplate that a decision giving preference to unionists should affect any legal right of non-unionist workmen. The non-unionist had no legal right to demand employment. He could sell his labor at what price and on what terms he chose, provided he could find an employer able and willing to accept his terms; but he had no right to demand that there should be an employor able and willing to accept his terms."

In other words, it would appear that the non-unionist can sell his labor if he can get an employer to run the risk of encountering vexatious and expensive legal proceedings, instituted by some union for engaging him instead of a unionist. For instance, if A, being a unionist, applies for work, and B, a non-unionist, applies, and the employer, knowing the non-unionist, and believing him to be the better workman, engages him, then A could set the law in motion, make the preference to the non-unionist an "industrial dispute," and put the employer to the trouble and expense of trying to justify his employment of B instead of A. What employer will run that risk? He finds it less expensive to submit to the law, and employ the less competent man, whom he does not want, than to fight it. In theory, he need only employ the unionist if he be equally capable; but, as the proving of the equal capability involves a lawsuit, the theory is impracticable.

In connection with this subject of trade and labor unions, one of Auckland's oldest and best known citizens and business men, who has for years employed hundreds of men in his factory, says:

"Any man living in the colony, and those who come after us, will, I feel sure, think very seriously of the effects likely to ensue, if the present suicidal policy of the unions continues. I wish to point out one or two cases. First, the tailors' union. Now, this body says to the masters, 'You must only take one apprentice to four journeymen.' Now, I propound a question for a life assurance actuary or the trade unions, viz.: Supposing Auckland employs sixty journeymen tailors now, with fifteen apprentices. How many of these fifteen may live to complete their indentures? How many would stick to the trade? How many would be worth their salt? Say that during the next twenty years there should be fifty apprentices indentured, how many in the above ratio would complete their indentures? It appears to me that instead of increasing in numbers pro rata with natural increase of population they would be diminishing, and, instead of handmade clothes, it will all have to be done by machinery, and the journeyman tailor will be a dream of the past. I am not in a position to say the number of journeymen engineers there are in the workshops of Auckland, but I understand their union says, 'You shall only have one apprentice to three journeymen.' The same reasoning applies as in the tailors' case, but with a much graver result. With the engineers it would not be so bad if it applied only to the workshops, and even there it is bad enough; but the workshops are the nursery from which you expect to rear all the engineers required for steam vessels and all other engines scattered all over the country. This is really alarming. Our machinery will have to stop if this goes on, or we will have to import engineers from Germany, Japan, etc., to keep our wheels turning."

About a year ago, the Hon. James W. Bucklin, a member of the Colorado Senate, was appointed by that body to visit Australasia to study its labor and school laws. While in Auckland, he was the guest of George Fowlds, Esq., a member of parliament, who is an avowed, out-and-out single taxer. After thoroughly investigating the labor laws in the colonies, Senator Bucklin wrote to F. G. Ewington, Esq., of Auckland, as follows:

"I became convinced that the evident prosperity of New Zealand was not owing in any material degree, if at all, to your so-called 'labor laws,' such as arbitration, early closing, eight hour and other restrictive legislation."

In conclusion, I quote from a recent article in the Herald:

"The ministers and a majority of southern members have again succeeded in administering a blow to Auckland. It seems that in the south the trades unions have succeeded in tying up the clothing trade by a 'log,' or plan of work, and scale of payment, which enhances the price of clothing, owing to the use of antiquated processes and methods. It is impossible, under the southern log, to adopt the best modes of work. In Auckland, on the other hand, the log of the clothing trade had been differently framed, and was constructed so as to fit in with the most advanced methods of working. The southern manufacturers were tied and helpless, and, as they could not make any improvements, they considered that the next best thing was to bring the Auckland methods back to theirs. The superiority of Auckland methods was telling, and ready-made clothing could be sent from Auckland, and sold at a profit in Dunedin and Christ Church and Wellington. This became so patent that Mr. Justice Martin, who presides over the arbitration court, wrote an official letter to the government on the subject, pointing out that, unless something were done, Auckland would become the manufacturing center of the colony, and would absorb a great part of the trade of the southern cities. In the discussion in the house, Mr. Bollard referred to this letter as being quite unjustifiable. If Auckland can become the chief manufacturing center by fair means and by natural advantages, surely the government has no right to step in and destroy these.

"But this is just what the government has done, by the assistance of the southern members. They have added a clause to the conciliation and arbitration bill, giving the court 'power to extend any award to any employer in the colony not then bound thereby or party thereto.' That is to say, that if an award is made under the Dunedin log in the clothing trade, the decision shall be binding in Auckland, although, owing to the different construction of the logs, it may be difficult to apply it. The logical result would be to abolish the improved machinery in use in Auckland, and to set on foot again the antiquated methods which have been fastened on the south by the log in use there, and sanctioned and confirmed by the statute.

"At present, the colony is divided into districts for the administration of the arbitration act, and this arrangement was adopted in order that local circumstances and methods might be taken into account. The amendment to the bill now before the house, enforced by the premier at the dictation of southern members, virtually annuls this. The prospect or chance of Auckland becoming the manufacturing center of the colony was apparently appalling to the ministers, and they have adopted this means to stop any prospect of that. No advantage of better machinery and better methods is to be allowed to tell."

Proposed Tunnel from Europe to Africa.—A French engineer named Berlier has recently proposed to the governments of Spain and Morocco the construction of a tunnel under the Strait of Gibraltar for the double purpose of establishing railway connections between France and Algiers and of bringing Morocco into closer connection with European civilization. Mr. Berlier believes that the construction of a submarine tunnel from Vaqueros Bay, in Spain, to Tangier, in Morocco, is perfectly feasible, as the depth of the sea in this vicinity does not exceed 400 meters (1,300 feet). The submarine length of the tunnel would be 32 kilometers (nearly 20 miles), the entire length being 41 kilometers (over 25 miles) and the maximum grade 25 feet per 1,000. It is proposed to establish railway connection in Europe by means of a line following the Spanish coast and passing through Tarifa and Algeciras. In Morocco a line would be constructed from Tangier to Ceuta, Tetuan, Melilla, and Remours, connecting with the Algerian railway system at Tlemcen. Mr Berlier is convinced that in building the tunnel sufficiently wide for two tracks, no greater obstacles will be encountered than those which have been successfully overcome at Mont Cenis, the St. Gothard, the Arlberg, and the Simplon. The accuracy of this opinion appears, however, doubtful, for the ventilation of a submarine tunnel and the removal of the constantly accumulating water would present great difficulties and prove very expensive. Nevertheless, Mr. Berlier believes that by using a new process, which is his secret, the cost would not exceed 3,000 francs ($579) per meter (39·37 inches). This is what the Simplon Tunnel cost, the amounts at St. Gothard and Arlberg being, respectively, 3,800 and 4,000 francs ($738.40 and $772). Mr. Berlier also thinks that by working simultaneously at both ends of the tunnel, 4 kilometers (2½ miles) could be completed annually, and that thus the work could be finished in seven years. In this case the total cost of the tunnel would be about 123,000,000 francs ($23,729,000). Placing the cost of the line from Tangier to Algiers at 90,000,000 francs ($17,370,000), the entire connecting line from Spain to Algiers would cost 225,000,000 francs ($43,425,000).

The French press criticises the project unfavorably, on the ground that it seems hardly credible that the passenger and freight traffic between France and Algeria could be diverted to this indirect and expensive route. It is also believed that Mr. Berlier has overestimated the earning power of the road in assuming that the daily traffic would amount to 600 passengers and 700 tons of wares, making the receipts from the tunnel 7,000,000 francs ($1,135,000) and the receipts of the land lines 6,200,600 francs ($1,196,600).—George H. Murphy, Consular Clerk at Magdeburg.

New Method of Laying Tramways in Germany.—Under date of October 23, 1900, Consul Hughes, of Coburg, writes as follows:

Various attempts have been made in Germany to devise a means whereby the destructive influence exerted by the passage of heavy electric tram cars upon asphalt pavements may be counteracted. Hitherto, these endeavors have been without definite result, but much has been said lately in praise of a system which is shortly to be subjected to a practical test in Berlin. Contrary to ordinary practice, in which the tram rails are laid immediately upon a foundation of concrete, and in direct contact with the superimposed asphalt, the new method consists in laying the rails upon a bed of coarse gravel, and running a line of hardwood blocks along either side. Experience has shown that ordinary pavements, with gravel and stone foundations in place of concrete, offer the greatest resistance to the influence of electric cars. It is assumed that the gravel or stone allows the rails more play, which is advantageous in that, despite great care in their manufacture, it is impossible to insure exact uniformity in the gage of the cars. The new method is also relied upon to reduce the noise caused by the cars running over the lines.

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No. 897. November 27.—Spanish Sheep and Goat Skins—Electrical Goods in Calcutta—Antwerp Ivory Market Utilization of Furnace Gas in Germany.

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The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Mahogany Coating for Wood.—Dragon's blood, 30·0; soda, 22·5; alcohol, 600·0. Filter the solution before use, whereupon the surface of the wood, rubbed with a solution of nitrous acid, is treated with it by friction.—Neueste Erfindungen und Erfahrungen.

Brown Shoe Polish.—The brown shoe dressing called "Ne Plus Ultra" is produced as follows: Take—

Water	18	litera.
Rosin oil	4½	"
Spirit of sal-ammoniac, conc.	1½	"
White grain soap	1·930	kilo.
Russian glue	1·590	"
Brown rock candy	0·570	"
Bismarck brown	0·070	"

Boil all the ingredients together, excepting the pigment; after all has been dissolved, add the Bismarck brown and filter. The dressing is applied with a sponge.—Seifensieder Zeitung.

Discovery of Boron in Coal.—Many things have already been found in coal. Without speaking of the innumerable products of coal tar, vanadium and gold have been discovered in the ash. Now M. Mayençon, the professor of chemistry, has detected the presence of boron in coal from the Ferrovillat mine at St. Etienne. Might not this be expected? Boron, we have been taught at the Polytechnic School, is a new relative of coal. Is there a better place for a relative than in the family circle?

The reactions employed by M. Mayençon to reveal the presence of boron are the following:

The yellow paper of curcuma is reddened by boric acid; the blue paper of turnsol is reddened slowly by the same acid.

Barium chloride, slightly ammoniacal, is precipitated blue by the alkaline borates.

Above all, the flame of hydrogen is colored green by boric acid or ammonium borate.

In operating the last reaction, he proceeds thus:

The ore supposed to be boron-bearing is crushed; then placed in a stoppered tube and moistened with a solution of ammonium chloride, or sodium chloride, or ammonium oxalate, or even of oxalic acid. A current of electricity is passed into the tube, and if boron is present, there is produced on the negative electrode a brown deposit, which is believed to be amorphous boron. What is certain is, that the wire, carried into the flame of the burner, gives to it the characteristic green coloration.—Translated from Vie Scientifique.

Quantitative Analysis for Small Quantities of Arsenic in Ores and Art Products.—Arsenic exerts a considerable influence in the mechanical properties of metals, iron, manganese, copper, bronze, etc., even when the quantity is small. So the determination of this constituent is often important.

The following method is applicable to the ascertainment, where the proportion is quite small; other processes being preferable for large quantities. The attack is produced on 5 or 10 grammes by the liquid, or by the dry method, according to the material.

Liquid Method.—In this, aqua regia is employed, then sulphuric acid; the material is taken almost dry to the sand bath; then it is treated with sulphuric acid quite diluted and boiling water is afterward added, and the matter is filtered and washed to a neutral reaction.

Dry Method.—The material is fused with 4 parts of pure, dry sodium carbonate. The operation is in a muffle at first with slow fire, then stronger, until it is gently fused; water is added, and it is filtered and washed to a neutral reaction. The filtered liquor is slightly acidified with chlorhydric acid.

In both cases the liquor contains all the arsenic.

For the precipitation and separation of the arsenic, sulphureted hydrogen is introduced in the liquor even to super-saturation; then it is filtered and washed with water slightly sulphydric. The residue is left on the filter, and thus digested for three or four hours in ammonia, with the addition of ammonium sulphydrate (10 c. c. of ammonia + 2 to 3 c. c. of sulphydrate), with the addition of 50 c. c. of water. At the end of the time mentioned it is filtered at the temperature of 80° C. and washed with a mixture of ammonia and sulphydrate.

Oxidation.—The liquor obtained is slightly acidified with chlorhydric acid; bromine is added, which redissolves the sulphur and arsenic peroxide. It is boiled, in order to drive off the small quantity of bromine in excess, until a yellowish, limpid liquor is obtained. If clouded, it is filtered.

Precipitation of the Arsenic.—The liquor obtained by the preceding treatment is neutralized by ammonia, then reacidified very slightly by acetic acid. The acidity ought to be scarcely noticeable; the liquor ought to be limpid; if not, it should be refiltered. The volume, although large, is not a drawback to the total precipitation of the arsenic, for the precipitate obtained is insoluble.

To the acetic liquor are added from 50 to 60 c. c. of a solution of quite neutral uranium acetate of 40 grammes per liter. The arsenic is precipitated in the state of uranium arseniate of a greenish yellow color, clear, gelatinous, and not adhering to the sides of the vessel. It is raised to ebullition and left to cool for ten or twelve hours; preferably, for convenience, during the night. It is then filtered with an ordinary filter and washed with water charged with ammonium acetate of 10 per cent., with a trace of acetic acid. Then it is washed with pure water, dried, and roasted at ordinary red heat. A precipitate of uranium acetate is obtained of dark olive green color. This is weighed and multiplied by the coefficient 0·1864.—Translated from the Revue de Chimie Industrielle.

Labeling Cover-Glasses for the Identification of Sections.—In preparing a number of sections fixed to cover-glasses or slides, for examination, it is sometimes desirable to mark them in a way that will identify them after passing through the various solutions, and mounting. The following has given perfect results:—Incorporate in equal parts of egg albumen and glycerine enough lampblack to pigment it sufficiently. If prepared properly, this solution will flow readily from a steel pen on a cover-glass or slide, upon which may be written the number of the section. After writing the number, hold the slide or cover-glass over a flame until the numbers are dry. Sections may then be fixed to the glass thus labeled, and carried through any solution without fear of losing their identity.—C. M. Thurston, Cleveland Homeo. Med. Coll.

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